

# TUKTOYAKTUK : Responsive Strategies for a New Arctic Urbanism

by

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Bachelor of Environmental Design  
The University of Manitoba, 2006

Submitted to the Department of Architecture  
in partial fulfillment of the requirements for the degree of

MASTER OF ARCHITECTURE  
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**Abstract :** The Canadian Arctic is facing a set of compounding crises that will drastically impact the future of its coastal frontier. At a time when climate change is having a detrimental impact on the Arctic landscape, Northern communities are on the frontline of resource development where industrial money promises major territorial and social change. In this way, the Inuvialuit population of Tuktoyaktuk will find opportunity in crisis as they strategically manipulate both the agendas of the petroleum industry as well as the federal government's own incentive for Northern development in order to construct a new coastal frontier and secure a post-oil economy defended from the rising sea. This form of oil urbanization provides an architectural and infrastructural imperative for this thesis, as change will occur rapidly and at a much larger scale than these communities could spark or manage on their own. The Tuktoyaktuk landscape will undoubtedly become transformed by the creation of occupiable, defensive infrastructure that secures new land on which to reimagine the arctic dwelling and its temporal interface with a rising sea and a changing economy.

Mobilized by the demands and goals of the Inuvialuit population, this thesis examines Tuktoyaktuk as an exemplary model for strategic modernization and development of remote Arctic communities on the frontline of industrialization. The goal of designing this enhanced urban structure is to make use of the finite economic opportunity to set up the framework from which the community will thrive and grow upon the retreat of the oil operations. By maximizing the opportunities that emerge from these complexities of place, we begin to unveil a unique and timely moment for architectural and infrastructural innovation.

Thesis Supervisor : Ana Miljacki

Title : Cecil and Ida Green Career Development Assistant Professor of Architecture



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To Miho, thank you for showing me how far you can really push a thesis. Our work together has truly inspired me in this chapter of my life and the next.

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Thank you Kathryn, my editor and dear friend, for imparting my text with yor linguistic eloquence. And to Kristin, you are the reason I have survived two rounds of architecture school. Thank you for believing in me and my project when I no longer did. It’s your turn next!

To my brothers, thank you for never letting me get “too girly”. You have instilled in me the toughness with which I took on the North.

Finally, to my parents for never flinching at my next crazy idea and supporting me all the way. Mom, your unending pride and love resonates no matter the distance between us. Dad, my partner in crime, thank you for traveling to the top of the world with me and being the first one to climb the oil rig! I look forward to the day when you can properly pronounce “Tuktoyaktuk”.

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# TUKTOYAKTUK

RESPONSIVE STRATEGIES FOR A NEW ARCTIC URBANISM





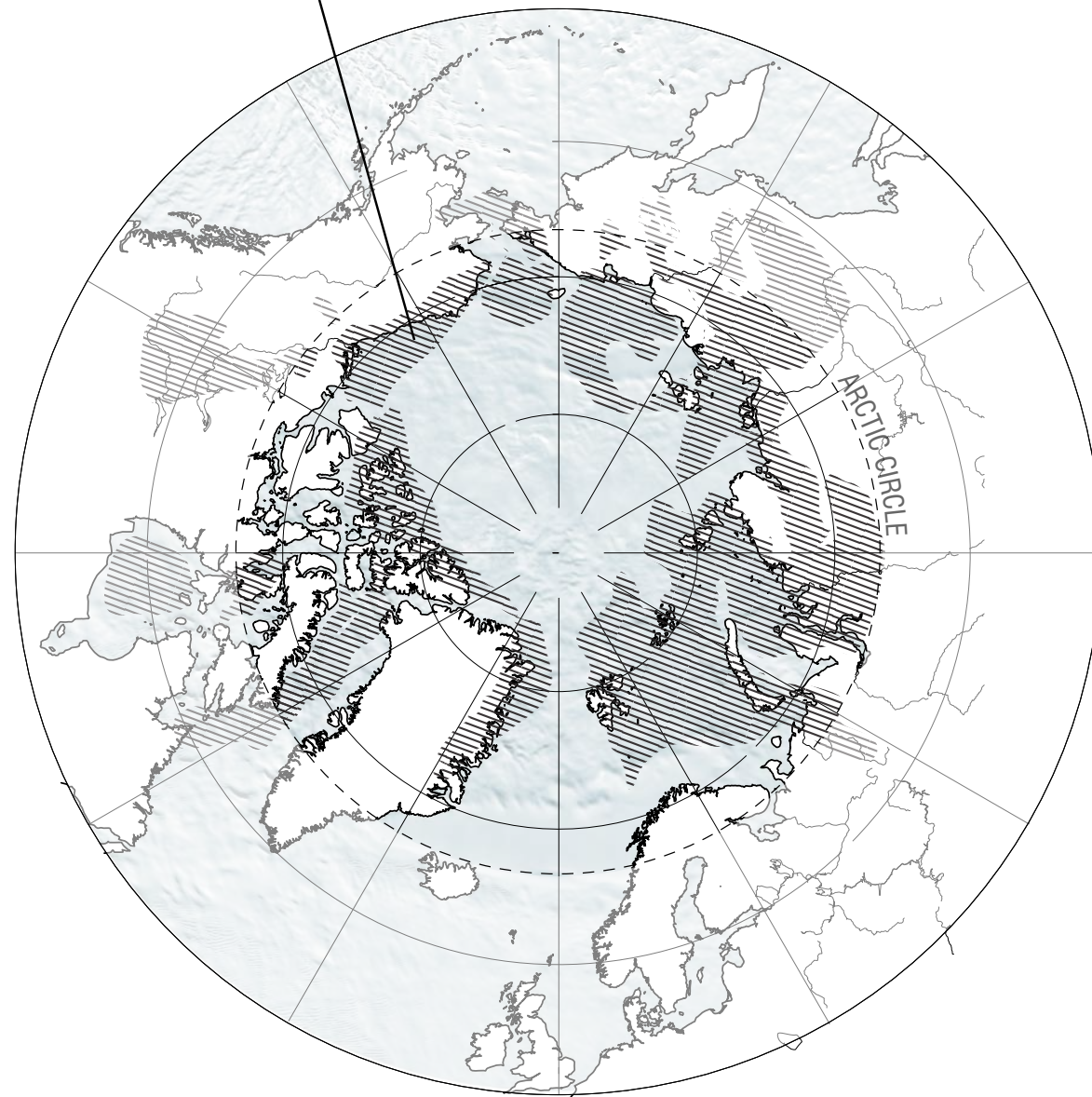
“Where the fuck is Tuk ? ...”  
- Mervin Gruben, Mayor of Tuktoyaktuk



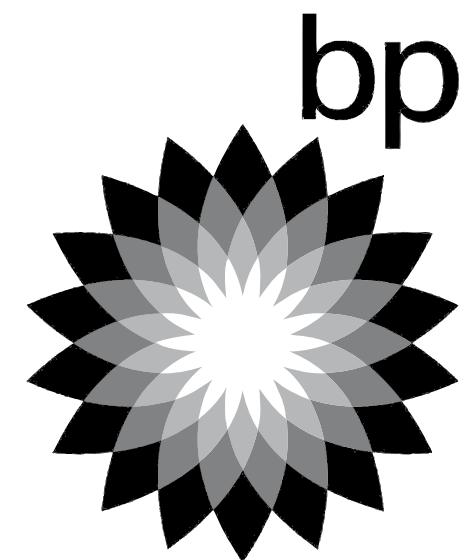
# INTRODUCTION

Finding Opportunity in Crisis

THE ARCTIC HOLDS **22%** OF THE WORLD'S REMAINING PETROLEUM RESERVES



84% OF WHICH ARE OFFSHORE

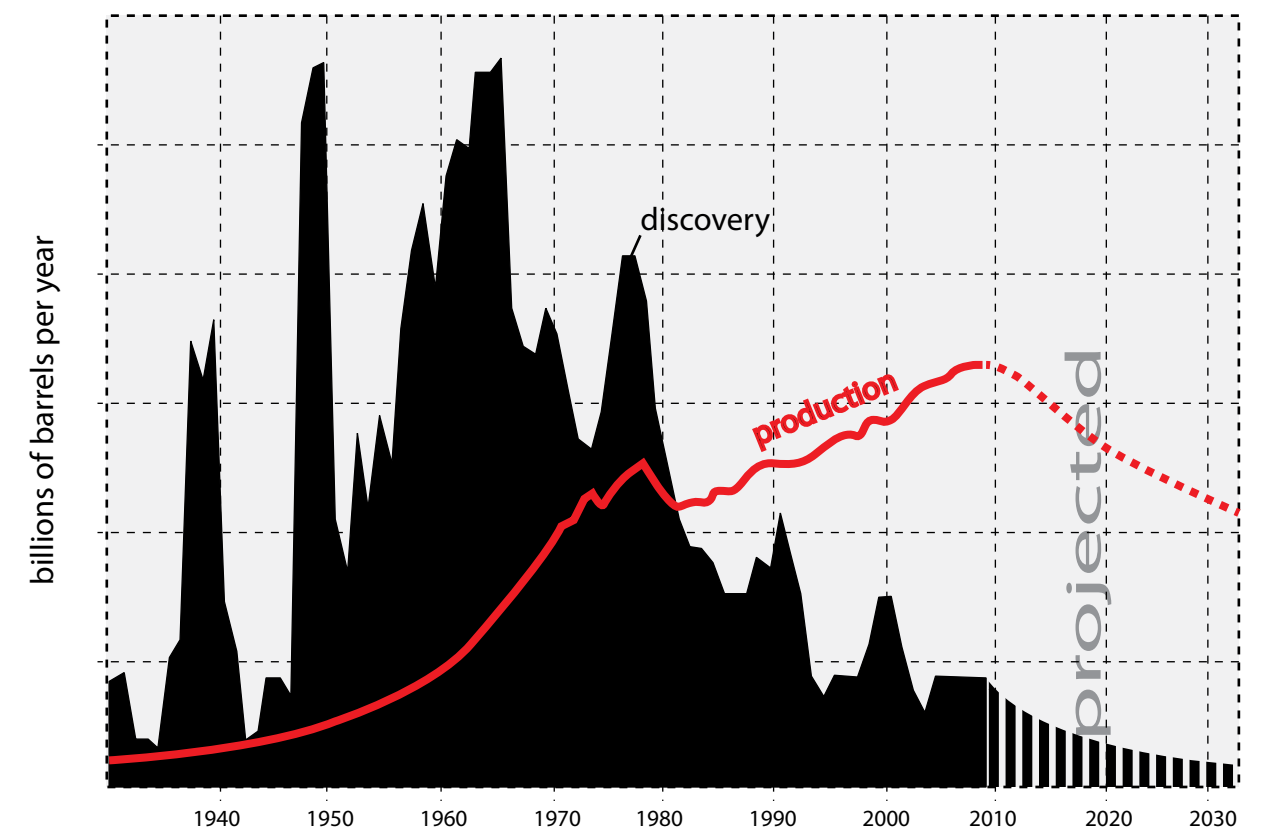


We're bringing oil to Arctic shores

<p>Preamble</p> <p>Finding Opportunity in Crisis :</p>	<p>Given that global hydrocarbon discoveries are beyond their peak and current production accounts for only half of consumption worldwide, petroleum exploration has expanded into the deepwater reserves that belie the rapidly diminishing armour of the Arctic icecap. The largest discovered oil resource North of 60 lies in Canada’s Beaufort-Mackenzie Basin bringing the race for oil in ice to focus on the land and coastal communities that occupy the edge of the sea. These areas become targets for rapid urban expansion, most notably through the exploitation of their minimal resources and onshore facilities as well as their prime geographic positioning. As exploration licences increase in the Beaufort-Mackenzie Basin, Canada’s Arctic communities foresee the threat of unfettered gas urbanism and the typical boom-and-bust cycles of resource development. In the 1970s and 80s, the rapid development, exploitation and eventual retreat of the oil industry characteristically expanded the Hamlet of Tuktoyaktuk in the Northwest Territories, only to desert all operations when the hopes of offshore oil development were no longer economically viable.</p>
<p>refer to images of Tuk on pp124-137</p> <p>refer to timeline pp50-51 and description of IFA p53</p>	<p>The economic, ecological and territorial damage wreaked by this phase of development mobilized the ratifying of the Inuvialuit Final Agreement, which defined the local Inuvialuit land claims and strengthened the native population’s control over natural resources. Similar to the close attention paid by the oil industry, the Canadian government has established a national imperative through their 2010 Budget that seeks to acknowledge the growth of Northern territories through increased frontier development. In this imperative, a community like Tuktoyaktuk, which sits as the critical gateway to the riches of the Beaufort Sea, is seen as a crucial federal frontier - a community to be expanded, not abandoned.</p>

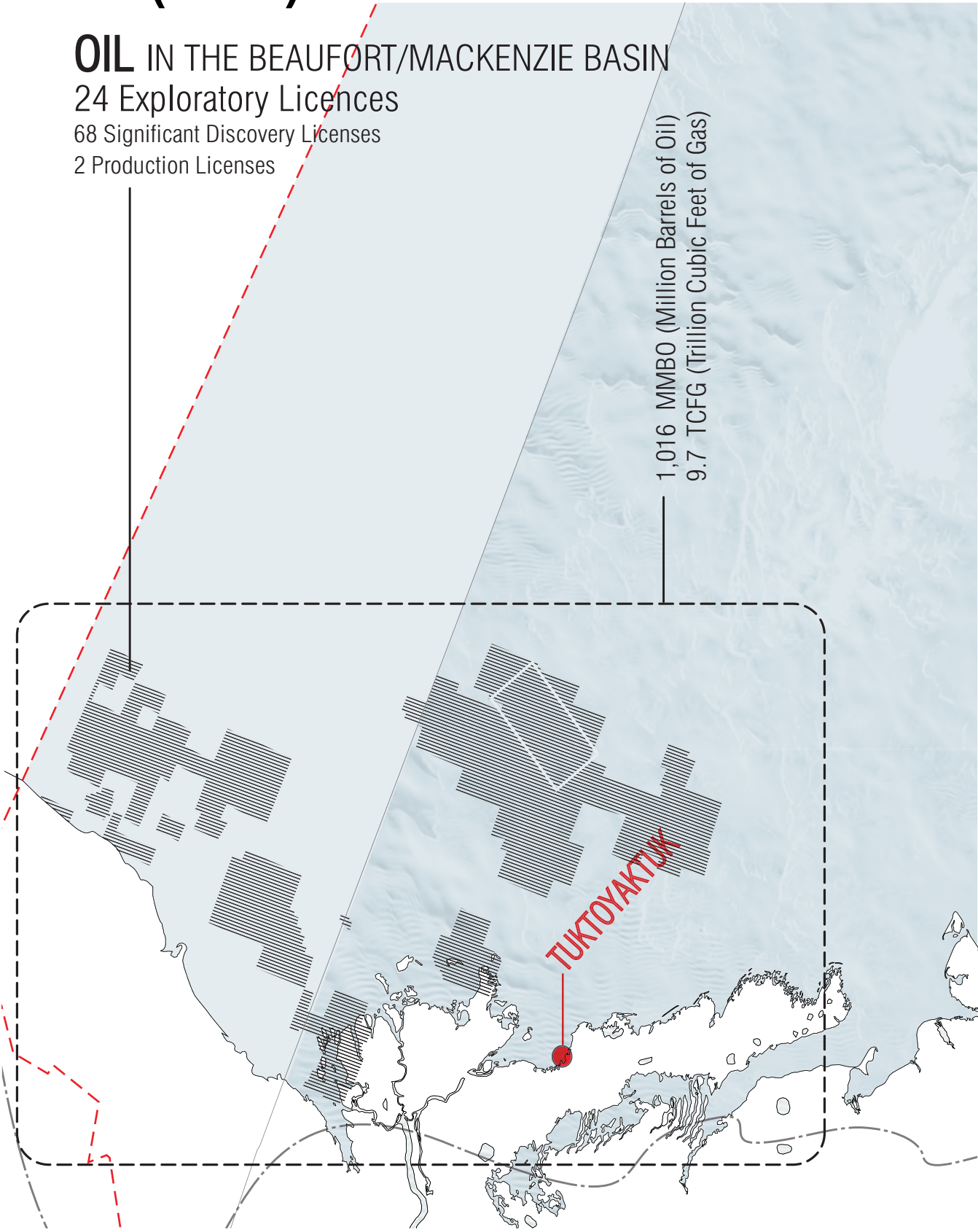


BY 2050 GLOBAL ENERGY DEMANDS WILL MORE THAN DOUBLE



PRODUCTION HAS SURPASSED DISCOVERIES AND CONSUMPTION GROWS

# Race to (remote) resources



GLOBAL OIL DEMANDS CONTINUE TO SUPPORT CONVENTIONAL AND UNCONVENTIONAL DRILLING, PUSHING EXPLORATION INTO OFFSHORE, FRONTIER AREAS.









## 1970's - 80's

FALL OF OFFSHORE EXPLORATIONS AND ONSHORE OPERATIONS  
IN TUKTOYAKTUK LEFT THE COMMUNITY IN ECOLOGICAL,  
INFRASTRUCTURAL AND ECONOMIC DESPAIR

# 2015 the players...



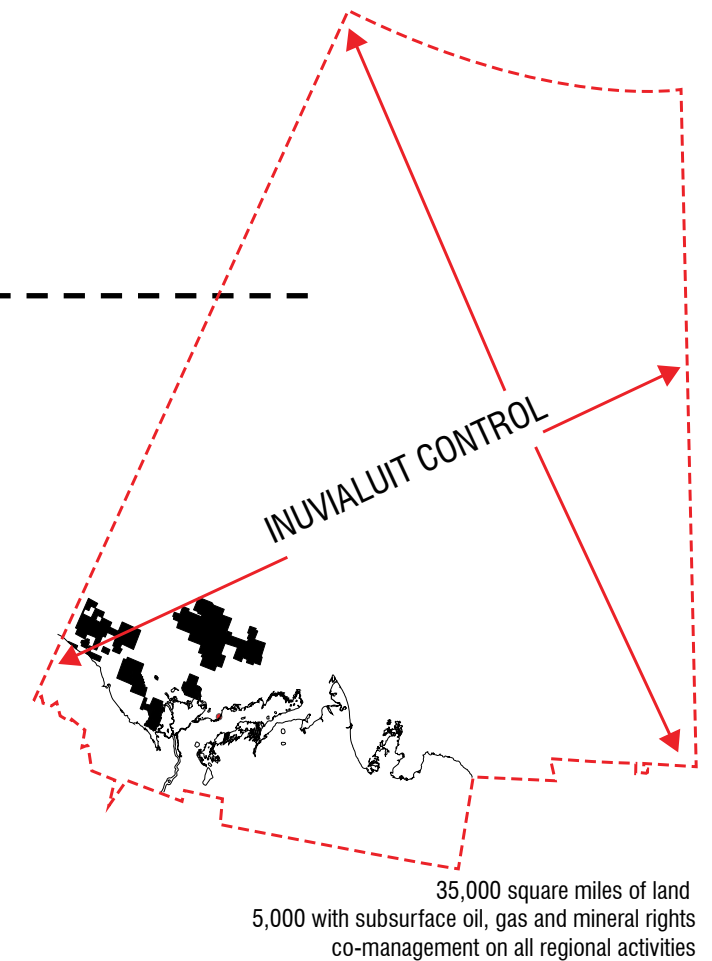
THE INUVIALUIT POPULATION OF TUK  
Victims of gas urbanism yet opportunistic  
capitalistic, and on the verge of modernization



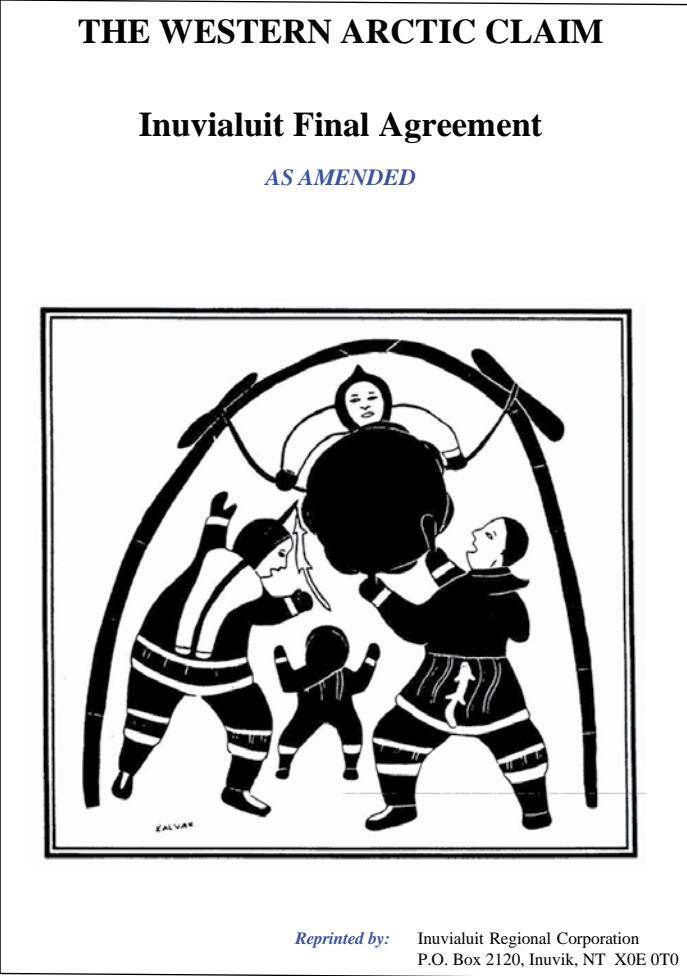
THE CANADIAN GOVERNMENT  
Slow to Flex its “Northern Muscle”



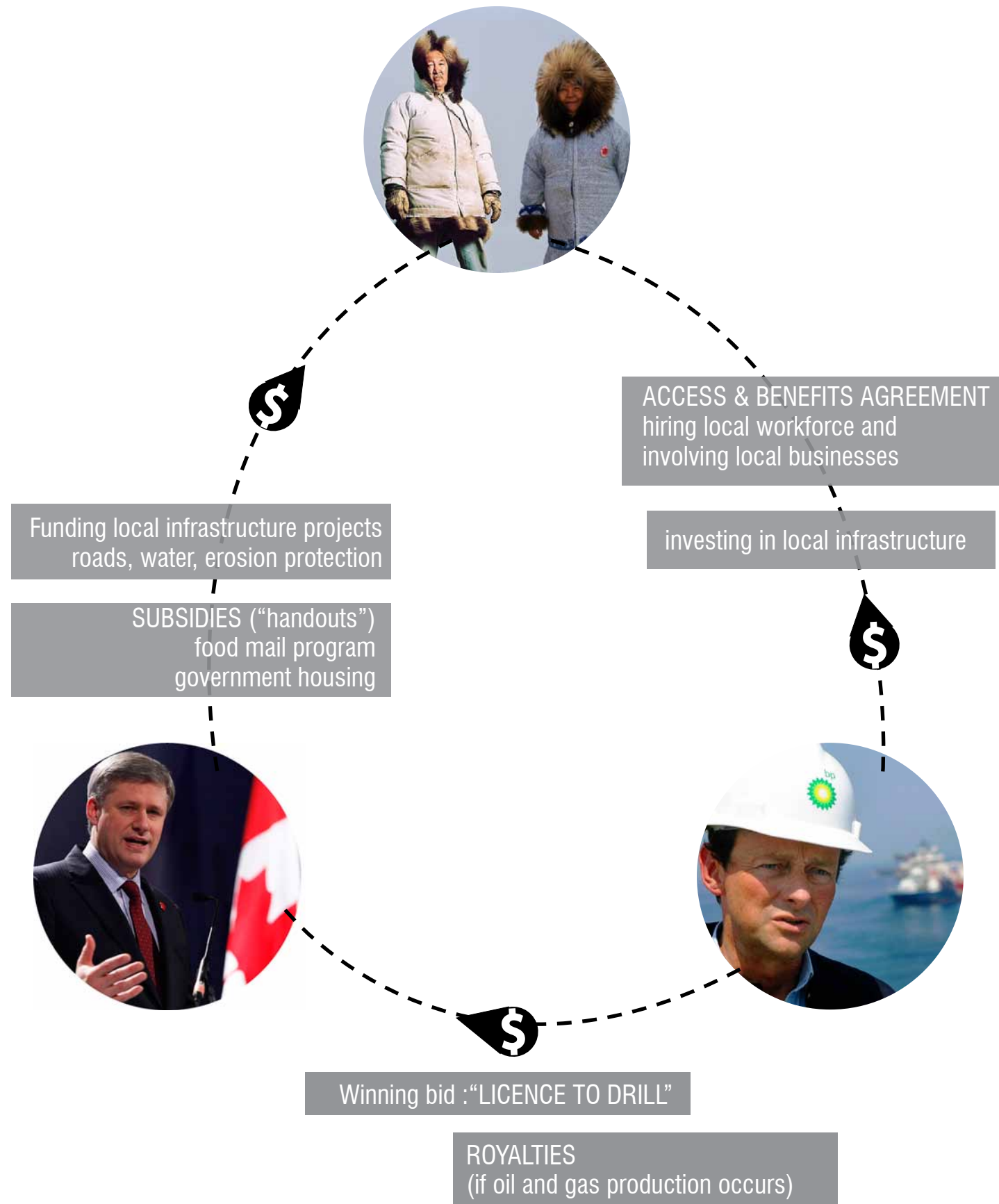
THE OIL INDUSTRY  
Reputation for economic and  
environmental destruction



Despite federal inputs, the Inuvialuit are operating from a recently empowered position from which they can enter into the current exploration agreements. As the owners and operators of the land within the Inuvialuit Settlement Region, they retain the final deciding factor on whether these offshore reserves will, in fact, be tapped. In their best interest, they will form a partnership for development with the oil industry and determine the provisions under which said exploration and onshore production will take place. “Reconstructing Tuk” will be their defining agenda, as they simultaneously siphon economic and infrastructural inputs from both the Canadian Government and the oil giants. In the end, this strategic partnership with the oil industry will allow the Inuvialuit to mobilize and modernize their population. They will enter an era of defining the new Arctic frontier as one that is able to grow under its own agreements and contracts, and therefore free from full-fledged reliance on federal intervention.

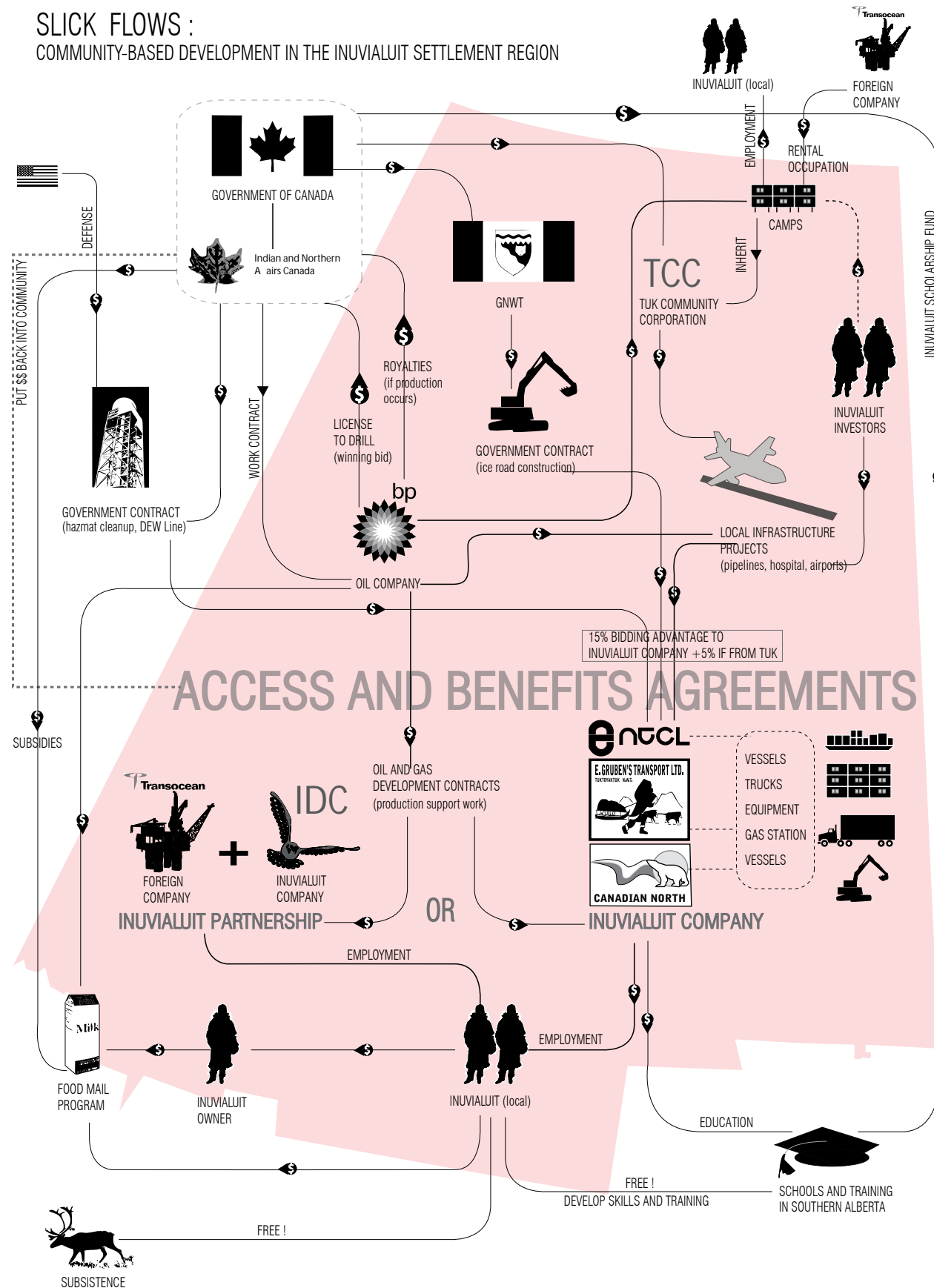


CONTROL OF SURFACE AND SUBSURFACE LANDS  
THROUGH THE INUVIALUIT FINAL AGREEMENT



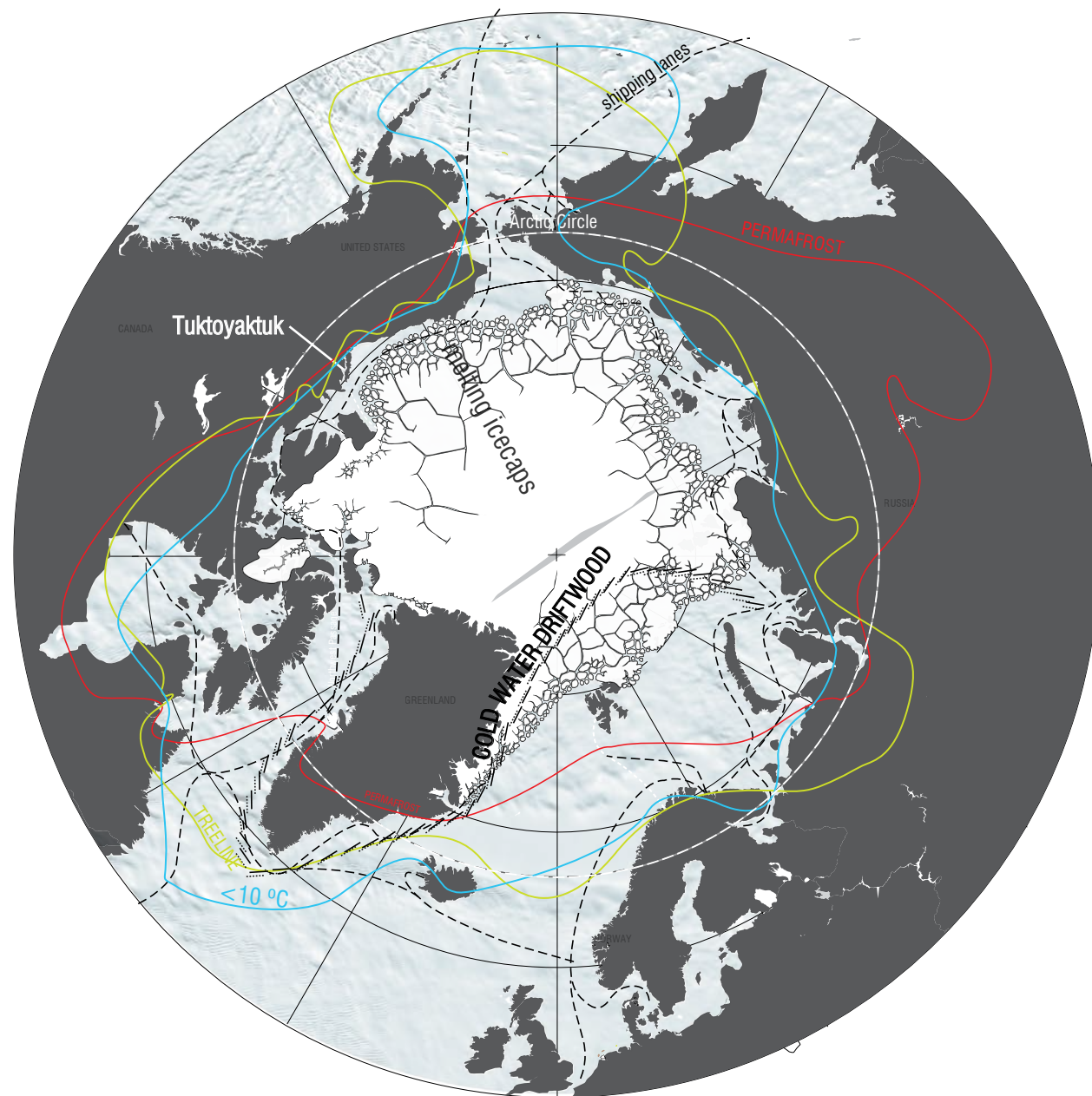
ECONOMIC FLOWS

## SLICK FLOWS : COMMUNITY-BASED DEVELOPMENT IN THE INUVIALUIT SETTLEMENT REGION



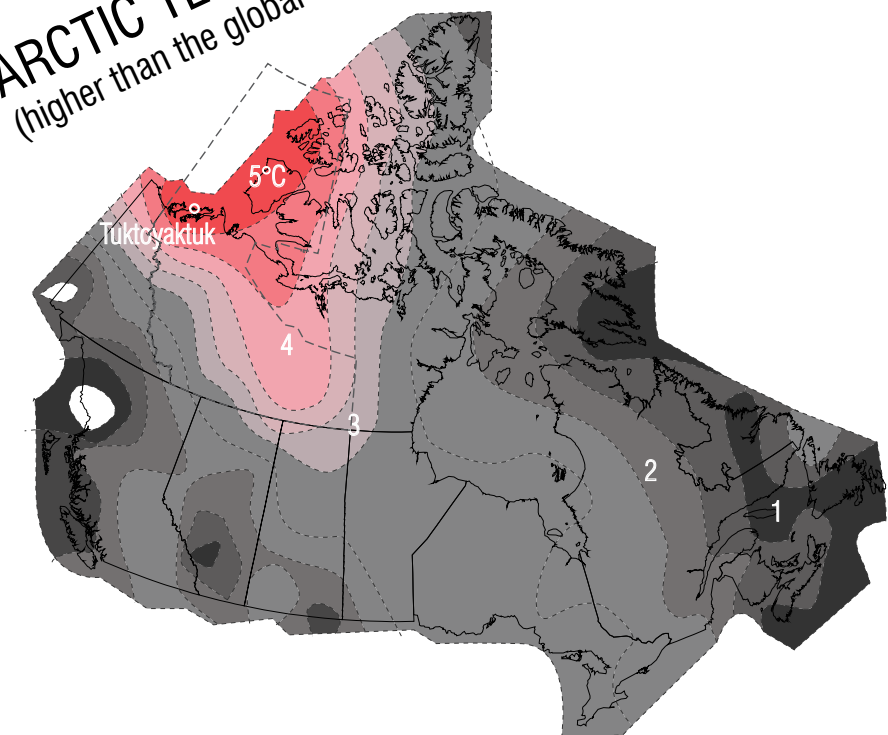
LESSONS FROM PAST EXPLORATIONS AND A HISTORY OF LAND AND RESOURCE DISPUTES BROUGHT THE SIGNING OF THE INUVIALUIT FINAL AGREEMENT WHICH WILL SECURE THE ECONOMIC FLOWS FROM ALL OFFSHORE ACTIVITIES BACK INTO TUKTOYAKTUK





TUK IS THE MOST NORTHERN SETTLEMENT ON THE CANADIAN MAINLAND,  
THE GATEWAY TO THE TO THE BEAUFORT SEA

ARCTIC TEMPS ARE UP 2.5°C SINCE 1970  
(higher than the global average)



TEMPERATURE DEVIATIONS FROM NORMAL (°C)  
Annual 1998

TUK IS THE ONLY PERMANENT SETTLEMENT ON THE LOW-LYING BEAUFORT  
COAST, A COASTAL FRONTIER IN A CHANGING LANDSCAPE.

Reconstructing Tuk :

refer to photographs of Tuk  
housing stock pp114-119

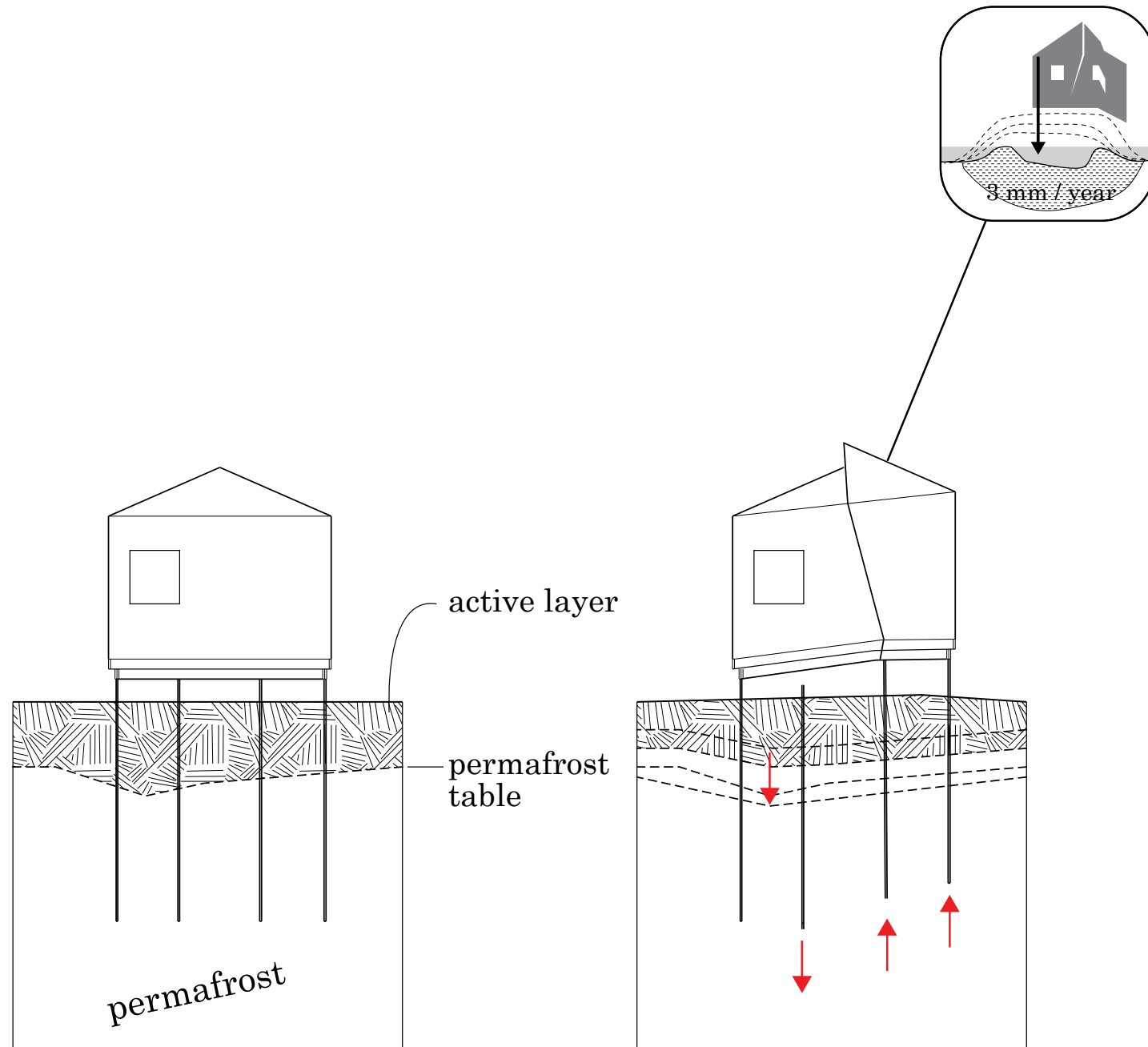
refer to p30

refer to pp28-29

Amid this geopolitical scene, lies the hamlet of Tuktoyaktuk, the most northerly settlement on the Canadian mainland and the single permanent gateway to the riches of the Beaufort sea. Typically covered by seasonal ice floes, the Northern coast is experiencing some of the most significant effects of climate change across the globe. These changes are seen in both a melting landscape and a marked vulnerability to an increasingly volatile sea. Tuk's karst landscape sees drastic seasonal inundation as its ground plane becomes both eroded at its edge, and melted to subsistence from within its permafrost foundation.

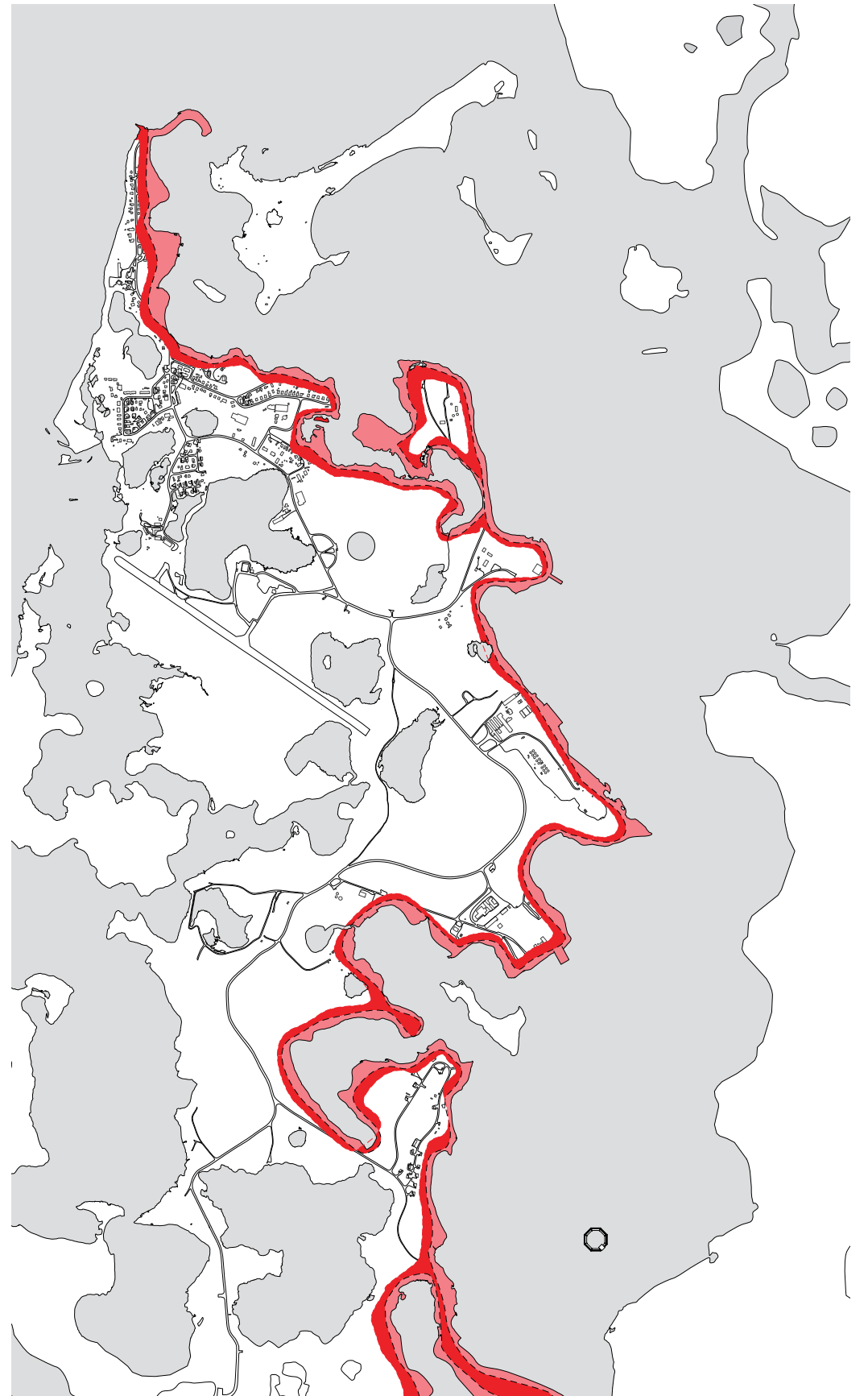
Compounding this crisis of Northern construction is the habitationally inadequate Tuk housing stock that is overcapacity, abandoned, and in major need of repairs. Inadequate housing coupled with a 2.2% annual population increase requires that Tuk move forward with a new and strengthened housing strategy. The housing crisis is fueled further by the offshore oil development as transient shift workers serving offshore and onshore operations multiply the local populations, straining already strained resources. Importantly, more than 1000 transient individuals are expected to flow through Tuk over the next fifty years of oil development and production.

While Tuktoyaktuk's economic and physical challenges already liken it to an "Arctic slum", the situation will have far worsened by 2050 as rising sea levels and melting permafrost will significantly inundate the remains of this troubled hamlet. Through storm surge and sea-level rise, it is predicted that 61% of the available landmass of Tuktoyaktuk will be lost to the sea. The majority of that land is currently being allocated to residential and open, cultural space - again raising the need for infrastructural solutions that combat this eroding, defenseless edge and envision a new Arctic urbanism.



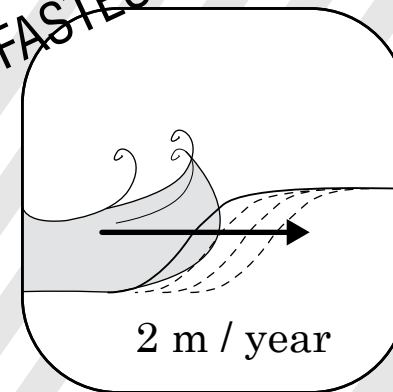
DAMAGING FROST HEAVE  
AND SUBSISTENCE







THE FASTEST COASTAL EROSION RATES IN CANADA !

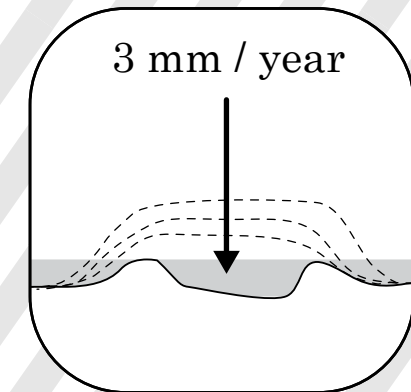


### EROSION !

CAUSES :

INCREASED STORM SURGE

WARMING OCEAN CURRENTS UNDECUT  
THE PERMAFROST BASE OF LANDMASS



### INUNDATION !





CAUSES :

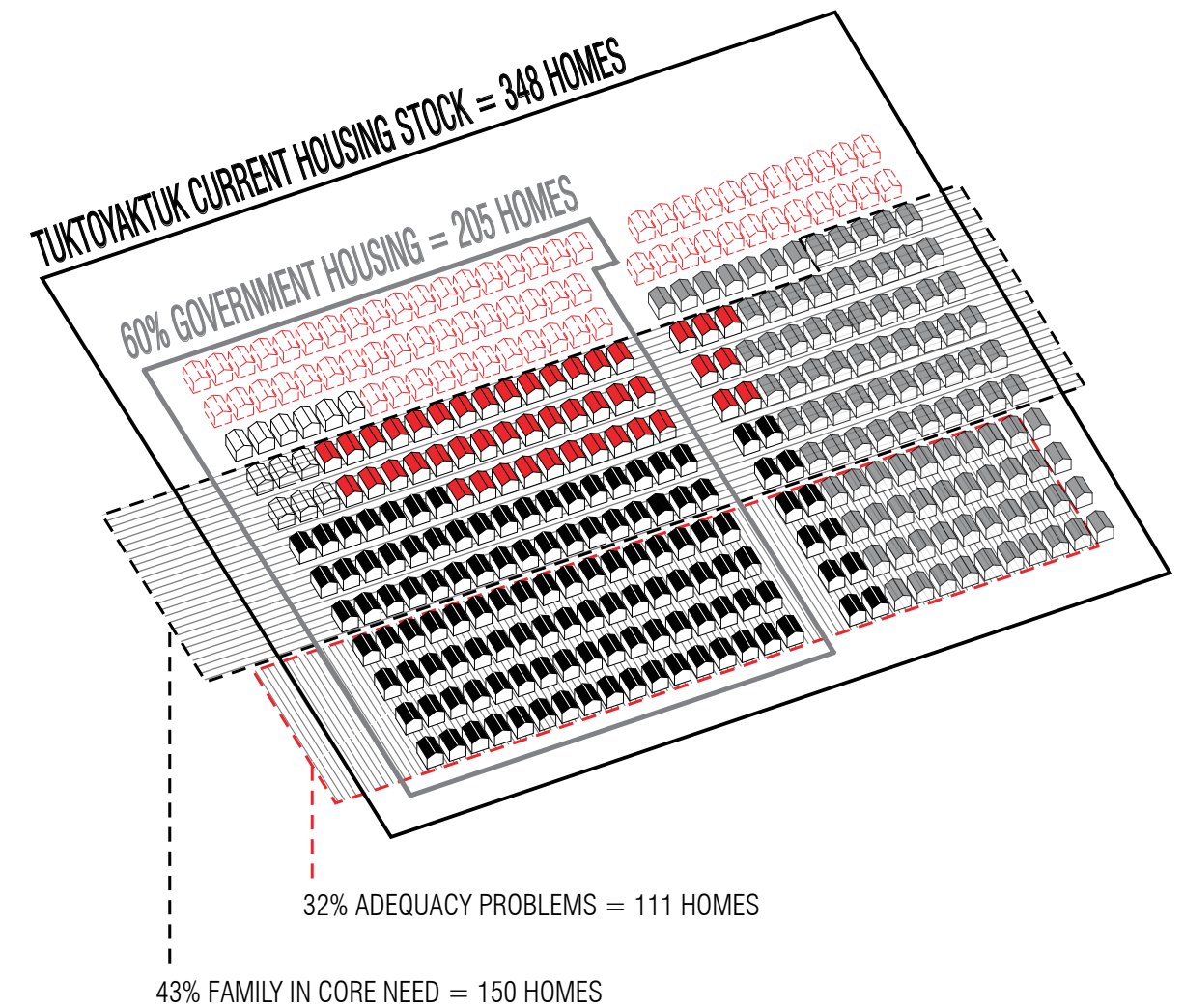
SUBSISTENCE : THAWED PERMAFROST

CLIMATE CHANGE : MELTING ICE CAPS

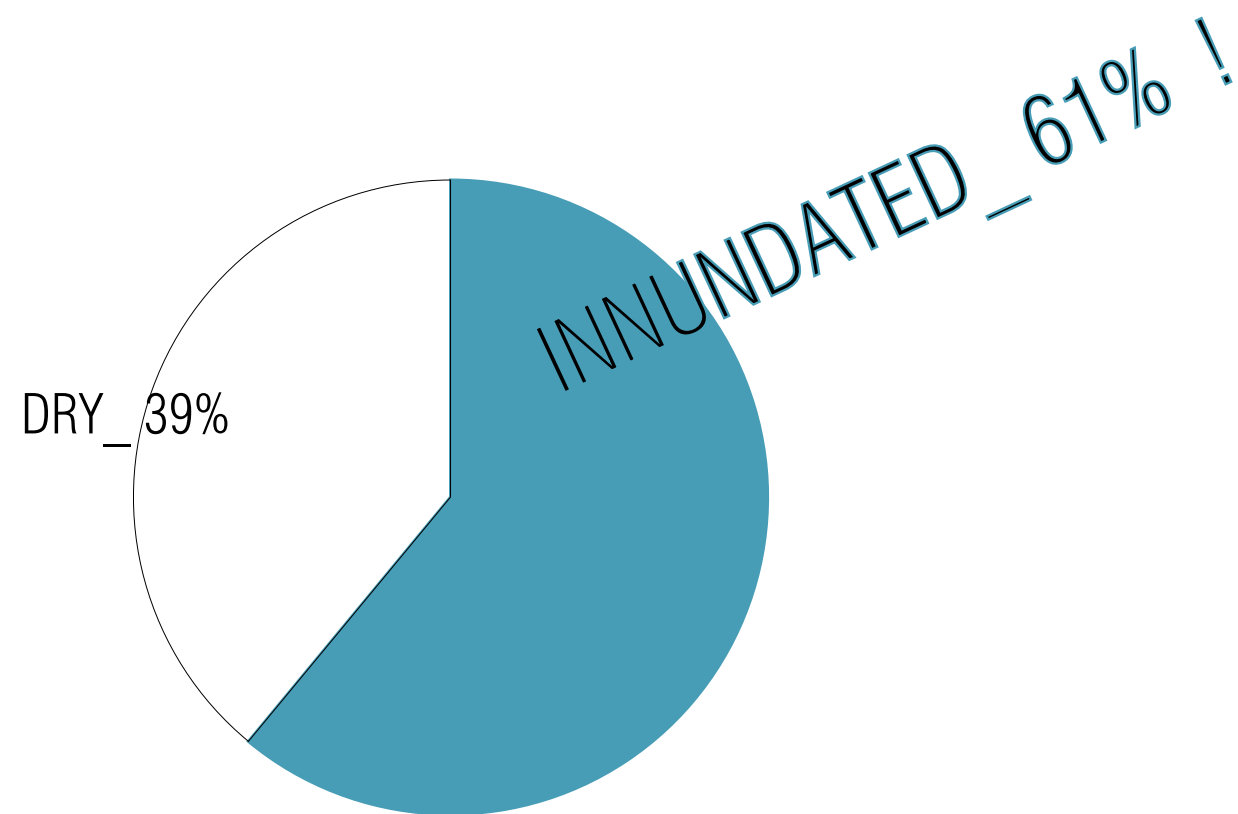
CLIMATE CHANGE IS DESTROYING TUK'S GROUNDPLANE :  
RISING WATERS, ERODING COASTLINES AND THAWING PERMAFROST.



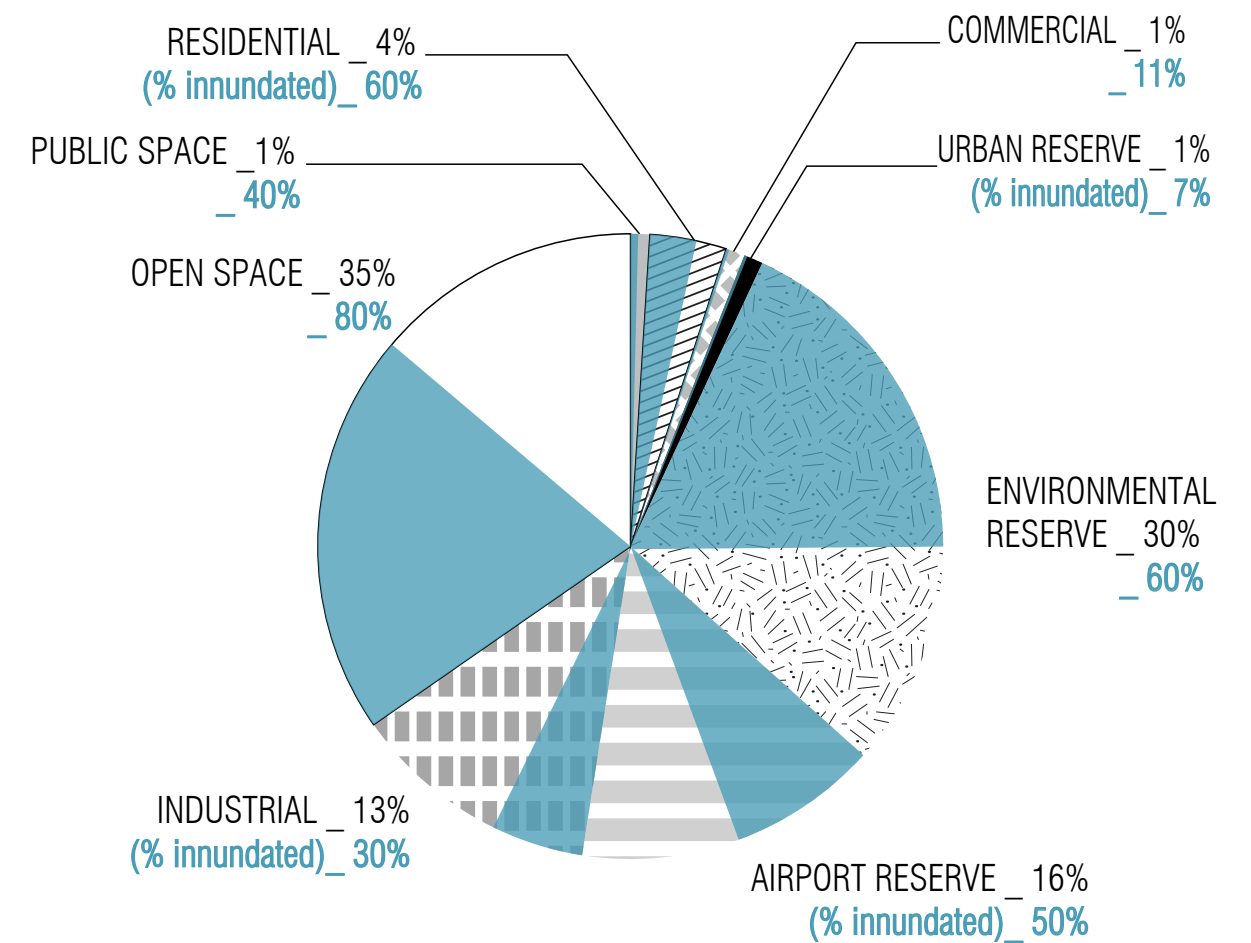
- 20% VACANCIES = 69 HOMES 
- 13% OVER-CAPACITY = 45 HOMES 
- 30% PRIVATELY OWNED = 104 HOMES 
- 34% NEED MAJOR REPAIRS = 118 HOMES 



THE TUK HOUSING STOCK IS IN A CRITICAL STATE OF DECLINE



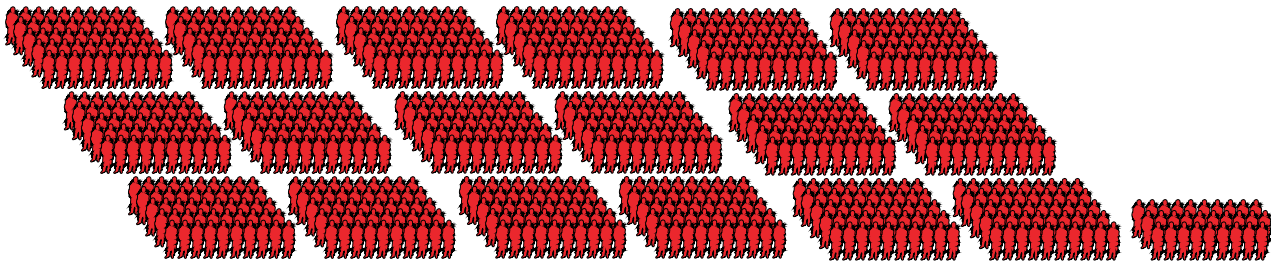
INCREASED EROSION, STORM SURGE, AND A GLOBAL RISE IN SEA LEVEL, WILL CAUSE THE LOSS OF 61% OF TUK'S LANDMASS



LOSS OF LAND WILL LARGELY ELIMINATE TUK'S PREDOMINANT OPEN SPACE WHERE TRADITIONAL FUNCTIONS OF THEIR PEOPLE OCCUR.



2010 POPULATION OF TUKTOYAKTUK

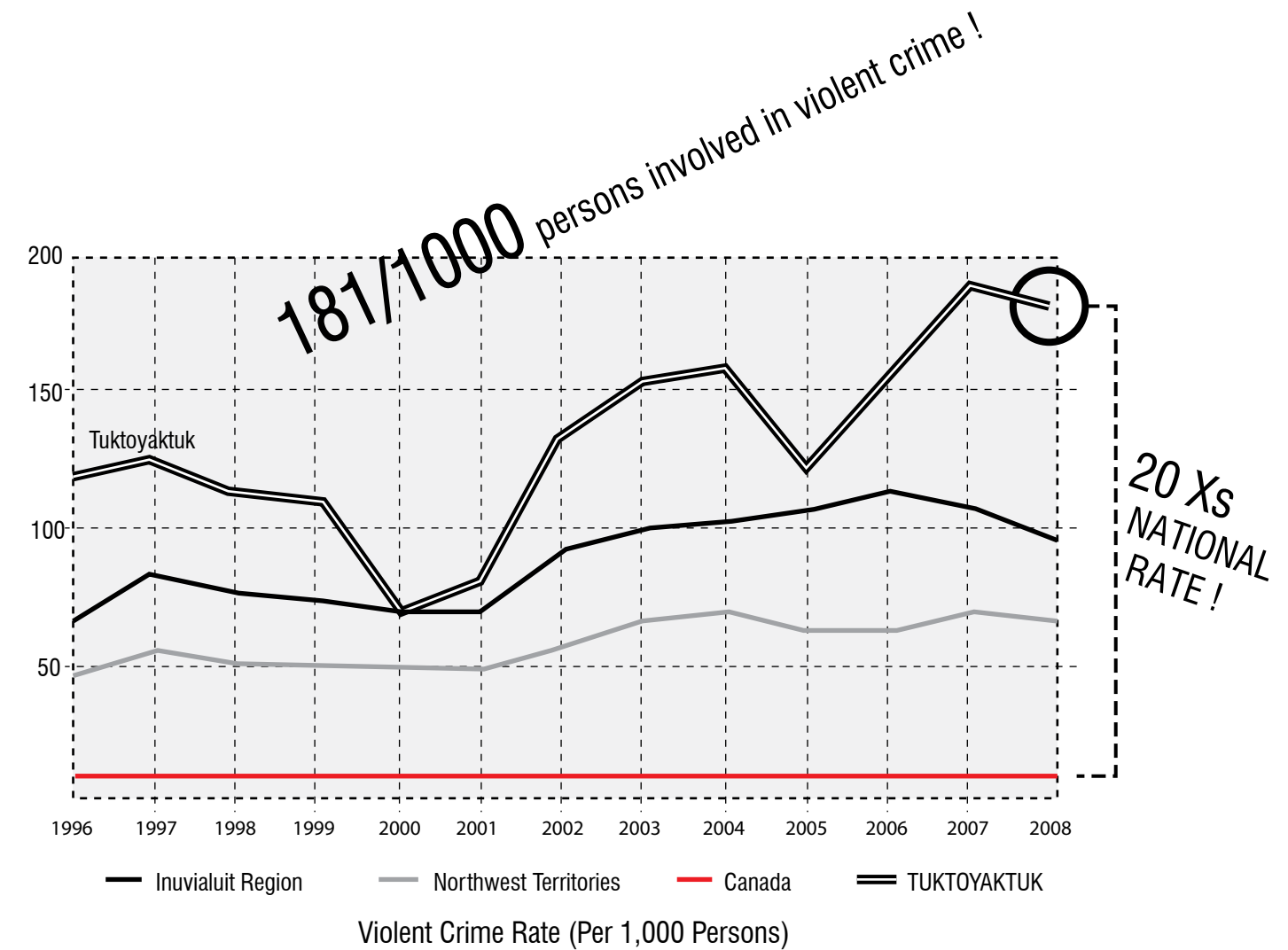
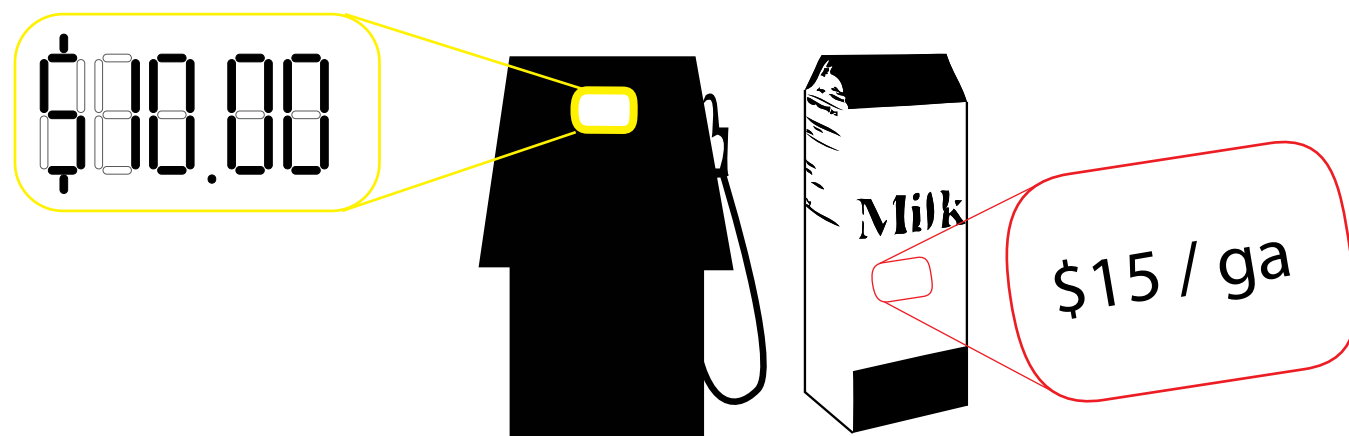


929

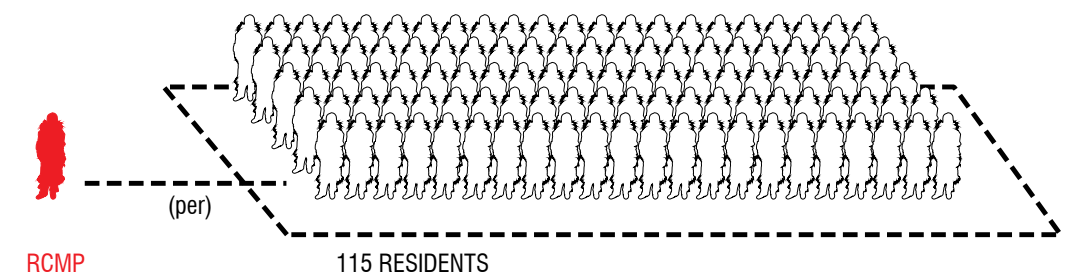
- 80 % INUVIALUIT
- 16 % NON-ABORIGINAL
- 4 % OTHER

OVER 1000

TRANSIENT WORKERS WILL TAKE UP RESIDENCE  
IN TUKTOYAKTUK OVER THE NEXT 50 YEARS.



## AVOIDING THE "ARCTIC SLUM" OF REMOTE LIVING

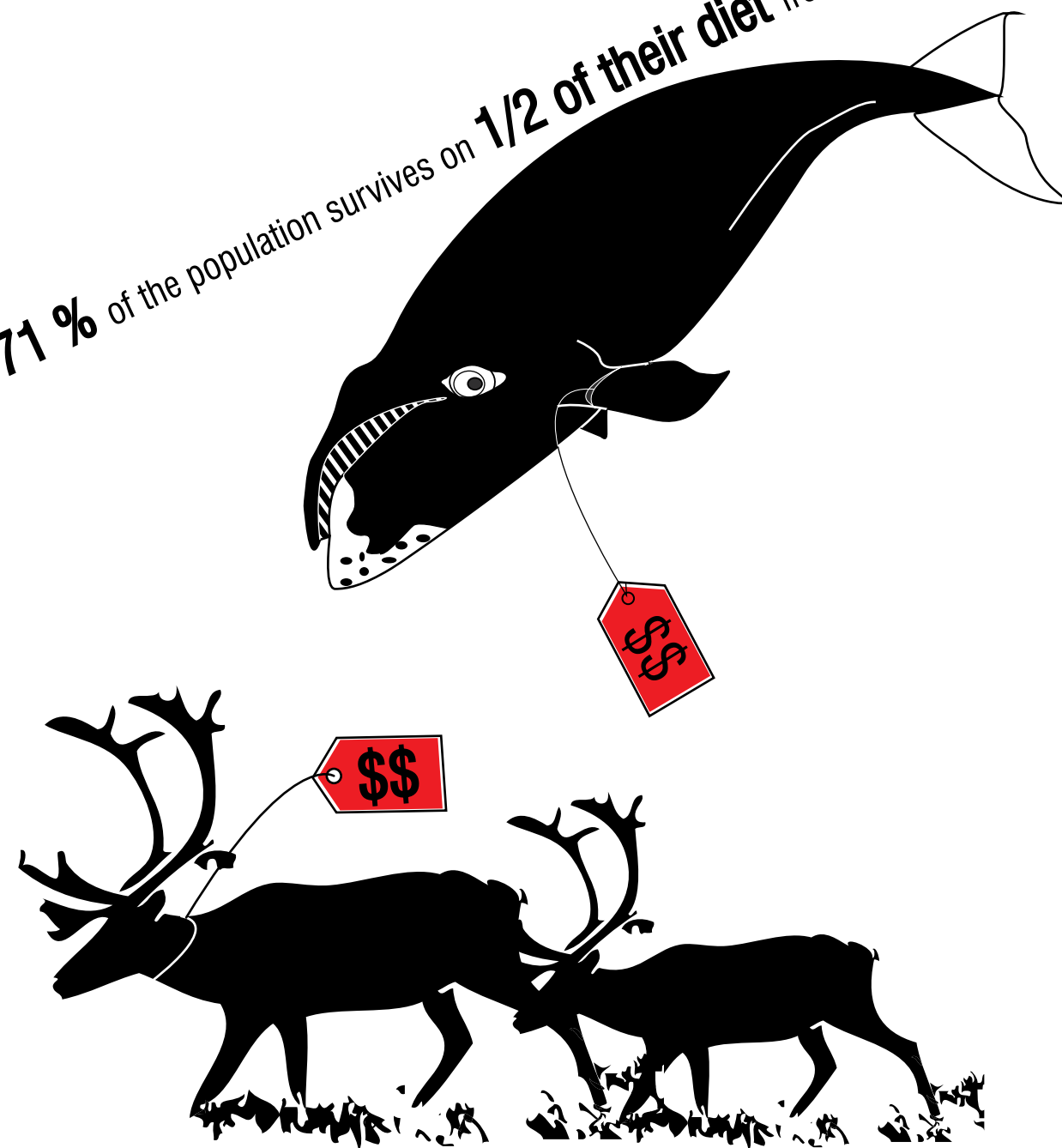


COST OF LIVING IS 1.5 - 6 TIMES HIGHER THAN THE REST OF CANADA

THE HAMLET OF TUK SEES A HIGH RATE OF DRUGS, ALCOHOL AND CRIME.



71 % of the population survives on 1/2 of their diet from “traditional foods”



THE RESIDENTS OF TUK ARE INTRINSICALLY LINKED TO THEIR LAND AND THE SEA





The destruction of the land also threatens the survival of the Inuvialuit population even further as it weakens their access to wildlife and their interactions with the complex ecologies of their living landscape to which they remain vitally linked. Without the ability to subsist through hunting and fishing, the people of Tuk are forced to accept the high food prices of the Government's Nutrition North program. This raises the reality of the dangerous costs of living in a remote community as well as the critical need to support local food production in this harsh climate.

## ■ ■ NUTRITION NORTH ?

THE CANADIAN GOVERNMENT PROVIDES A FOOD SUBSIDY PROGRAM THAT INCREASES CONSUMPTION OF PROCESSED FOODS



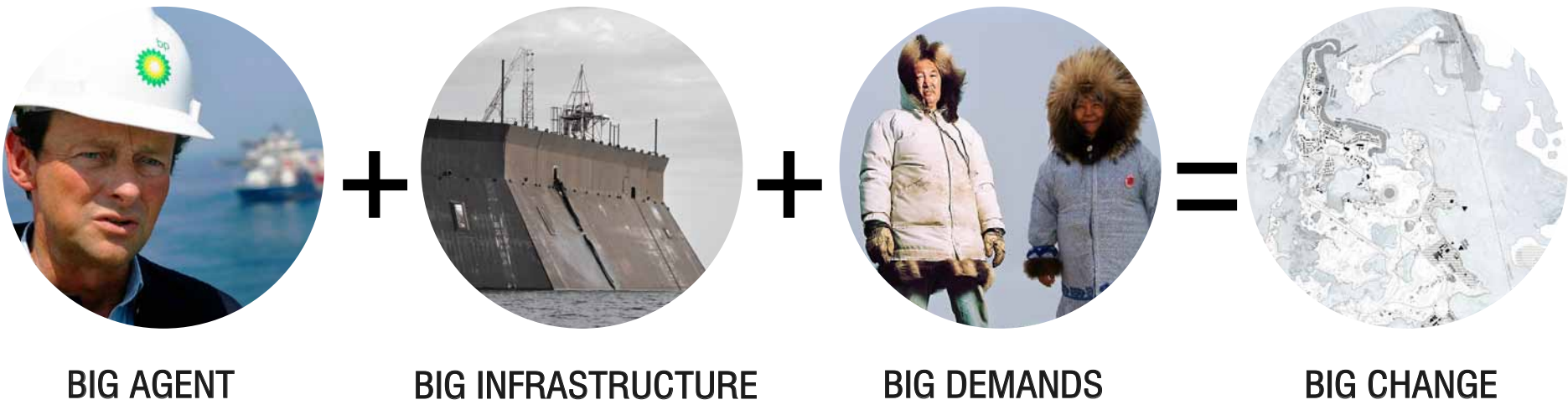


Manipulating Strategic Partnerships :

It is from this peril that this project gains its architectural and infrastructural imperative. By establishing the provisions from which oil development can take place, the Inuvialuit people can be empowered with a mechanism for economic, environmental and infrastructural change. The presence of a big agent with big money facilitates change at a much larger scale and a faster pace than this small population could attain on its own. This partnership will mobilize the modernization of their society over a finite period, leaving the Inuvialuit with an enhanced urban structure that will see varying phases of occupation over the course of the entrance and retreat of the oil industry as well as the rise and surge of the sea.

The premise of the project is to piggy-back on the mega-developments of the oil industry in order to set up large-scale infrastructures that both secure the present growth of the local community and strategize for the eventual retreat of the oil industry. For this to occur, the infrastructure - likely after about forty years of use in industrial production - must be turned over to the native population for the sake of local use and the cultural production of a modernized coastal community in 2050. At this time, the economy will transform from one base on resource extraction and industrial services, to one driven by a more highly-skilled coastal economy poised for subsistence but also engaged in the global operations afforded by a strengthened marine infrastructure. This infrastructure will open Tuk up as an access point along the Northwest Passage and allow it to serve as an operable harbour for Northern logistics.

Industrial development will begin with the construction of a concrete caisson seawall to act as barrier, access and occupiable vessel as it reconstructs the coastline. From this foundation, a landpacking strategy behind the caisson structure will establish new high ground on which to continue construction. This groundplane will secure permanent housing and transform unused open, recreation and civic spaces for the local population. As a layered strategy, this defense mechanism constructs a harbour that registers changes in sea level allowing the seawall to perform in gradients as an interface with the sea. Throughout the phases of oil production, rising sea level will weave together the industry and the community, creating a vital maritime economy from a functioning occupiable harbour.





## BIG DEMANDS

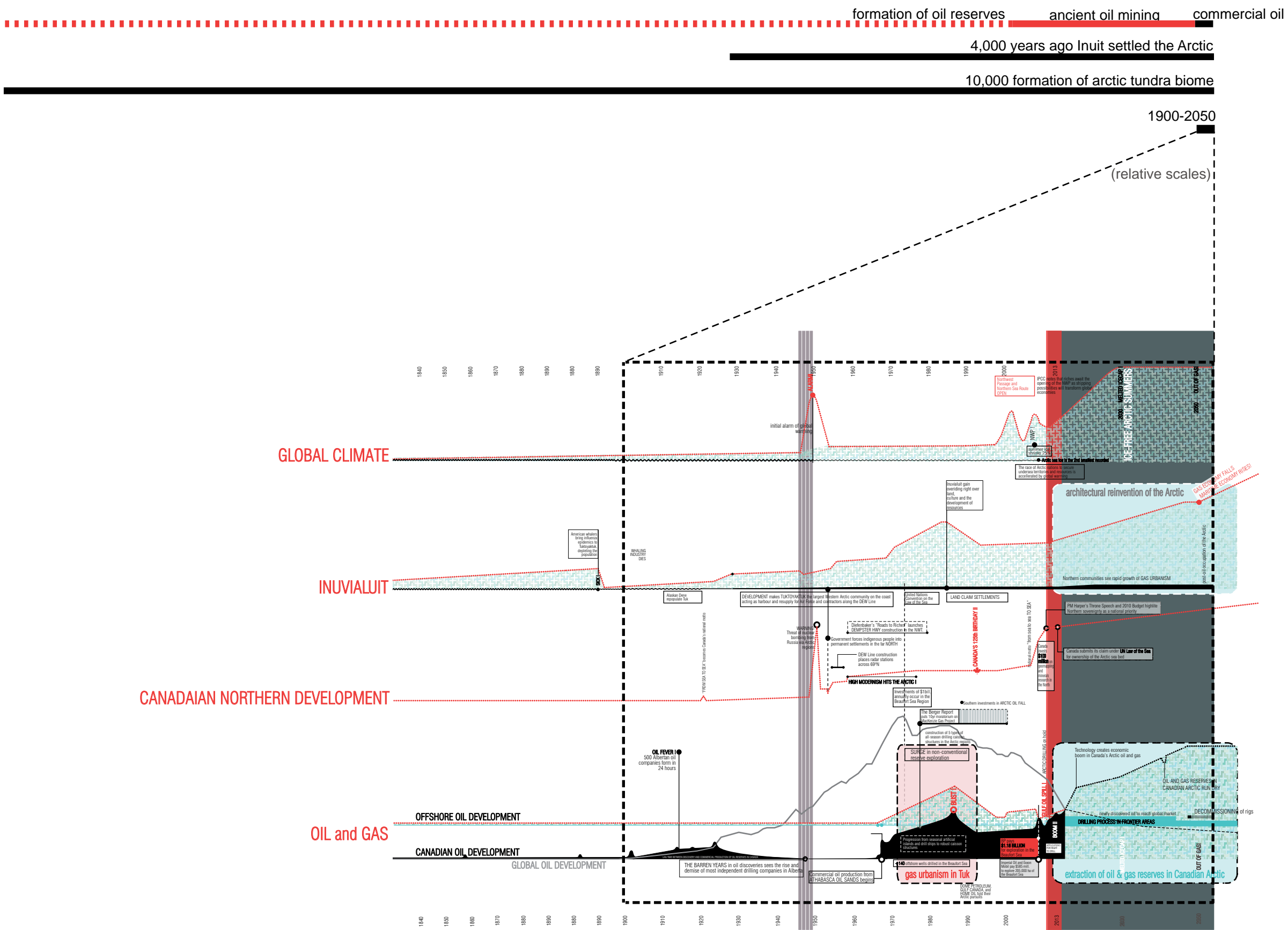
# PROVISIONS FOR DRILLING

- #1 : CONSTRUCT A DEFENSIBLE, HABITABLE EDGE THAT ACTS AS A VITAL INTERFACE TO THE HARBOUR AND ITS RESOURCES
- #2 : SECURE A LAND-RECLAMATION STRATEGY THAT PROVIDES NEW, HABITABLE LAND ON WHICH TO CONSTRUCT THE NEW ARCTIC DWELLING.
- #3: CONSTRUCT THE COASTLINE SUCH THAT IT SETS UP THE COMMUNITY FOR ITS FUTURE EXPANSION AS A MARITIME ECONOMY.
- #4 : BUILD AN INFRASTRUCTURE THAT FACILITATES THE PHASED OCCUPATION OF THE COASTLINE AS CONDITIONS OF SEA LEVEL AND FEROCITY CONTINUE TO CHANGE.

see “DESIGN” chapter

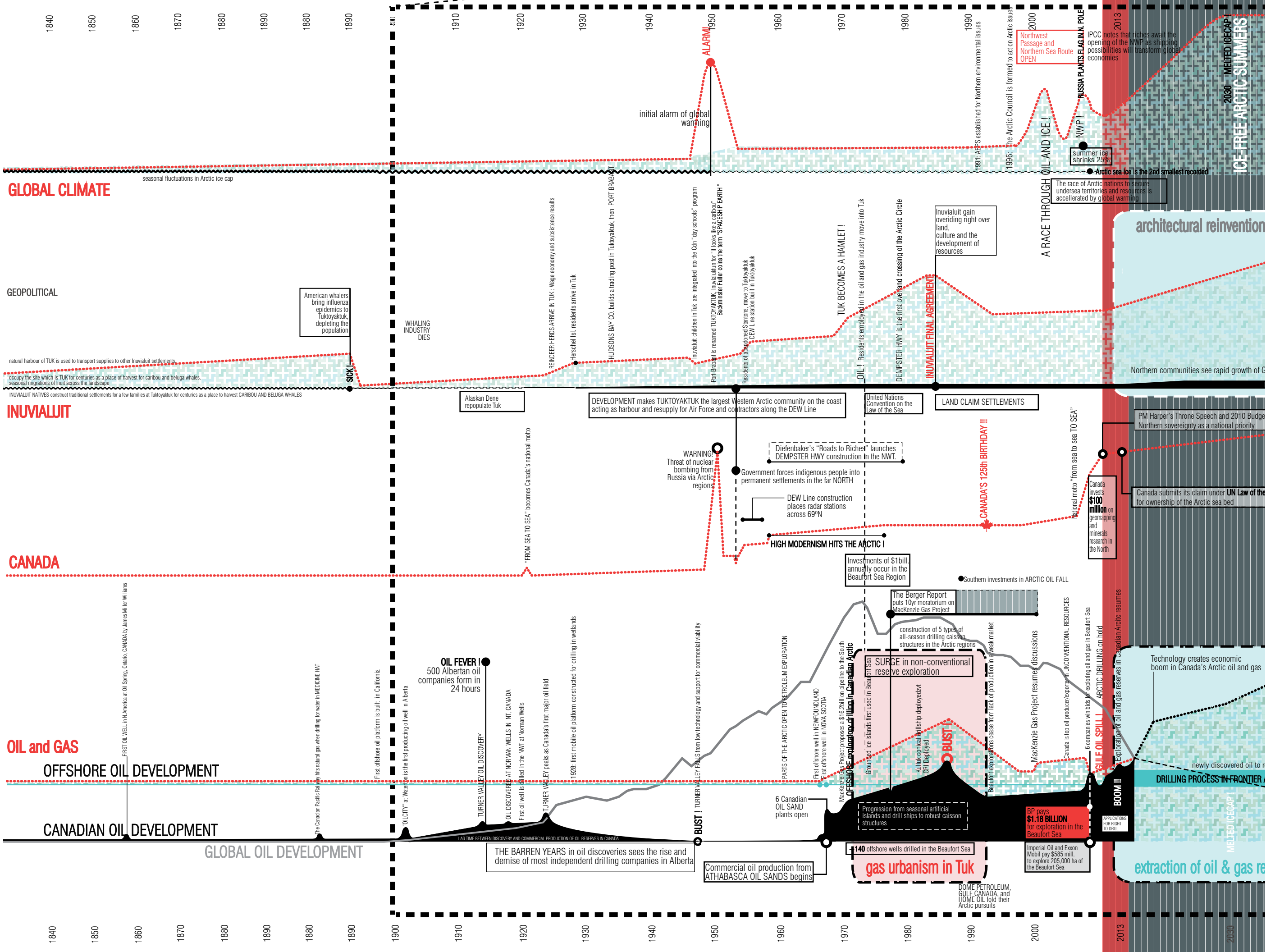
As time progresses and the conditions of the sea and the melting icecap become more volatile, the urban plan will accept the eventual flood and erosion of specific parts of its original landscape. Certain programs will change, spaces will disappear, and these infrastructures will adapt from sitting on dry land to partial submersion or floating conditions. In this way, a seawall and abutment strategy will be implemented to re-establish the landscape and revitalize the remote community.

Additionally, these infrastructures must be built with an understanding of the Arctic climate as the construction will occur in a volatile environment. Sea-wall construction and abutments will need to respond to an active sea, while on-land constructions must be mindful of the permafrost foundation.



## CONTEXT

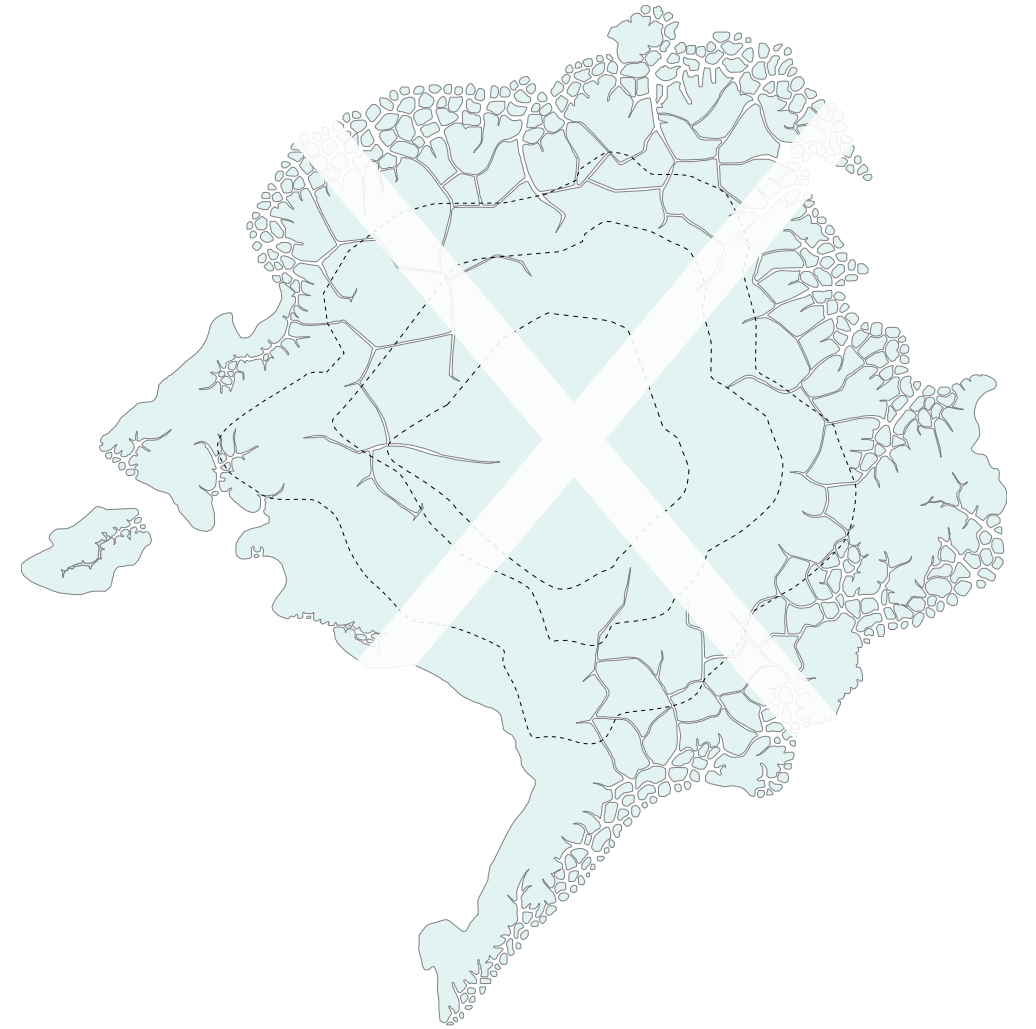
Uncovering a History of Disputes, Growth  
and Overlapping Crises



Unraveling Context :

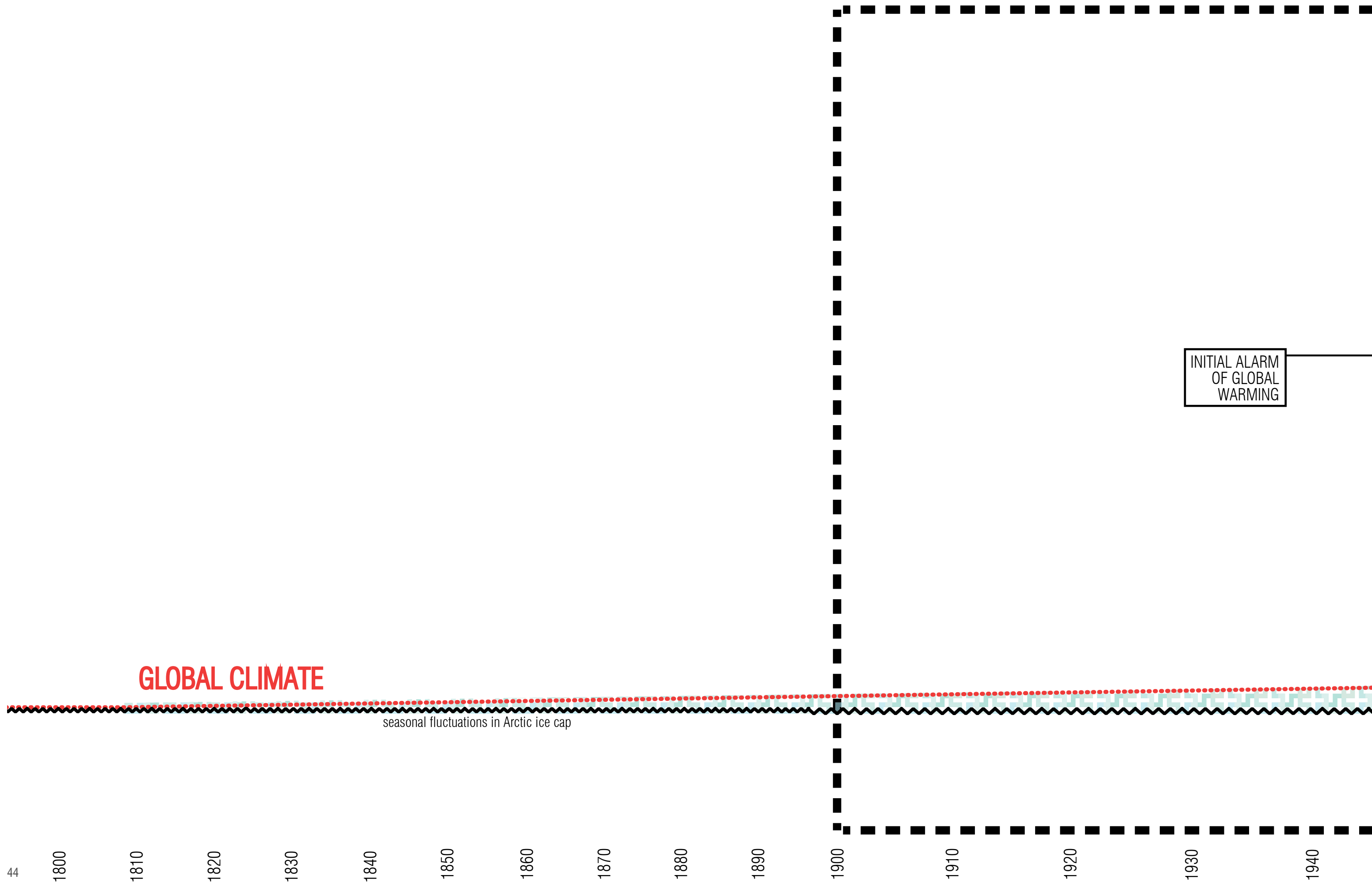
A concern for the Arctic commonly surfaces in a multitude of present-day debates and discussions that involve - and yet extend endlessly beyond - the discourse of architecture and urbanism. The Arctic has become a global concern of a highly complex nature, and is in the midst of experiencing the effects of several major overlapping crises, operations and opportunities. These are occurring across four streams of issues, which are documented in the timelines to follow. These four issues will have a drastic and marked effect on the urbanization of the Canadian Arctic in general and on the hamlet of Tuktoyaktuk in particular. This community of the Northwest Territories at the edge of the Beaufort Sea is at a fork of the crossroads where its people, history and landscape will witness the unique confluence of the issues involved in this Northern crisis. These four issues are : the global crisis of climate change as it is rapidly reshaping a once-frozen land; the history of cultural and geopolitical struggles of the Inuvialuit in the western Canadian Arctic; the history of federal control over its northern population and northern development (or absence thereof) in their own Arctic lands; and finally, the influence of oil and gas development, particularly offshore, through the ability and willingness of the industry to reshape this Canadian Arctic frontier. A frontier indeed, but if played correctly. This thesis suggests we are coming upon a uniquely aligned moment when these issues can be manipulated and strategized in relation to one another. By monopolizing on the strengths of each, and by mitigating or lessening their weaknesses, we might be able to reduce the negative impact on the Arctic landscape and instead witness a future of monumental urban and architectural opportunity. *Tuktoyaktuk: Responsive Strategies for an Arctic Urbanism* unravels more than a century of conflicts and events that have each helped to shape and construct the narrative of the North, thereby setting up this era of opportunity. By uncovering these contextual analyses, this project propels the Canadian Arctic into a period of strategic development that will reap immediate benefits and posture the region for self-sufficiency well into the following decades.







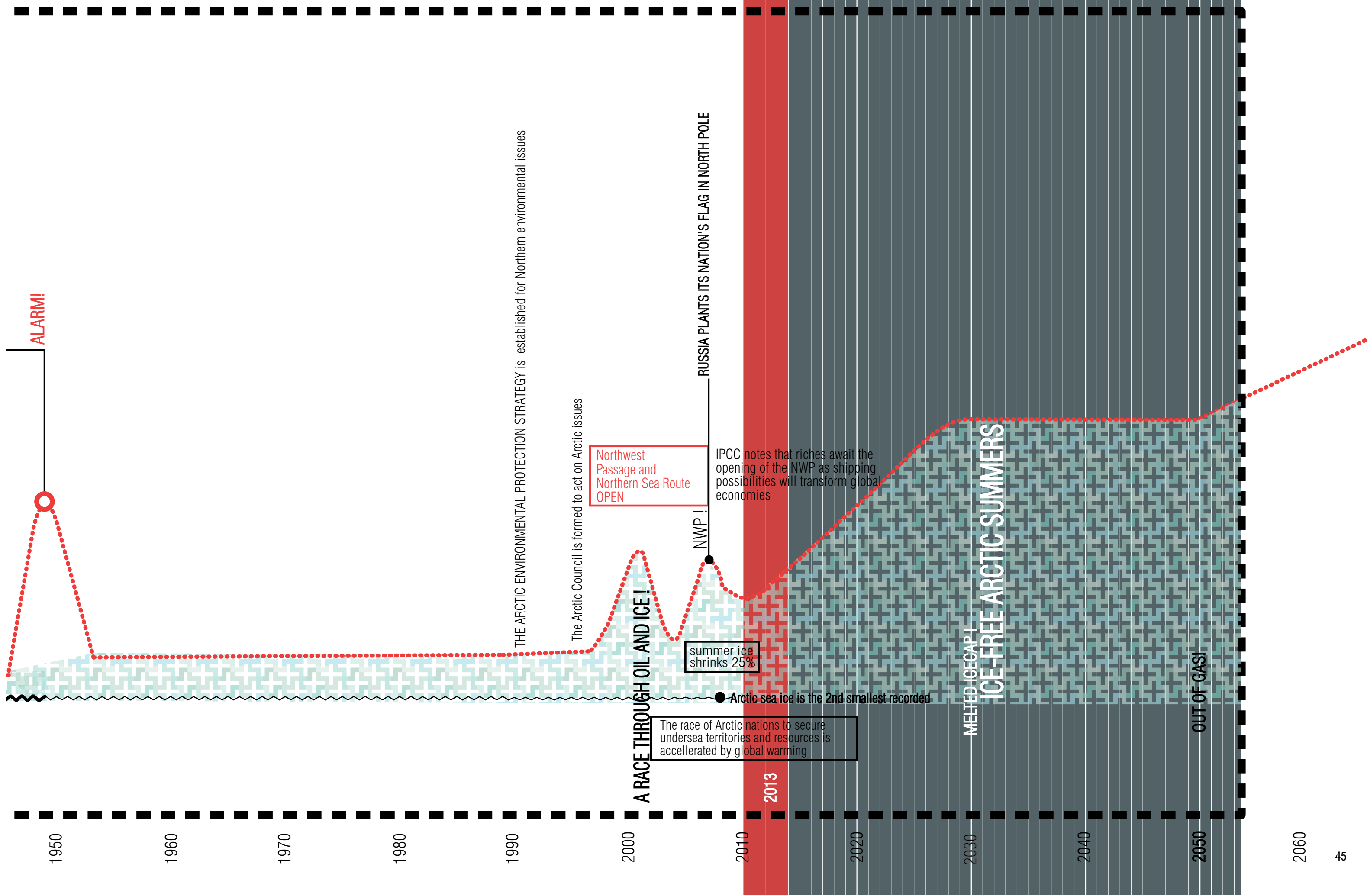
# 1. GLOBAL CLIMATE CHANGE



GLOBAL CLIMATE

seasonal fluctuations in Arctic ice cap

INITIAL ALARM  
OF GLOBAL  
WARMING





With the longest coastline in the world, and spanning nine times the landmass of California, the Canadian Arctic is threatened by climatic disaster in a manner not seen elsewhere on earth. For centuries, the North has been imagined as a land of eternal ice, an impermeable expanse of frozen terrain bounded by the sea. But the 2004 Arctic Climate Impact Assessment (ACIA) found that the arctic climate is experiencing increased temperatures at nearly twice the rate of the rest of the world.<sup>1</sup> As warmer air temperatures melt the top layer of highly reflective snow cover, insulation at the upper surface of the ice is decreased. Simultaneously, increases in greenhouse gases are causing a rise in sea temperatures, which is in turn melting the multi-year sea ice from its underbelly. The resulting rise in global sea levels increase the surface area of open water, allowing this liquid mass to further absorb atmospheric heat. Consequentially, this absorption compounds the polymorphous destruction, as the great polar ice sheets - which hold 75% of the world's freshwater - are shrinking beyond their expected seasonal flux. This alarming rise in sea levels threatens coastal security worldwide, making this Polar condition a matter of global concern.

At the local level, Arctic communities - especially coastal cities - are reminded daily that their landscape is literally slipping into the sea. Coastal erosion and slumps are an ever-increasing reality, and are threatening many communities with relocation and reconstruction. In turn, the number of environmental refugees in the North is on a dramatic rise. The Intergovernmental Panel on Climate Change (IPCC) has noted the damages that await our global population as sea levels rise. These claims are supported by the Environmental Justice Foundation, which posits that some 150 million people will be displaced due to environmental crisis worldwide by 2050.<sup>2</sup> This "climigration" makes sea-level rise, flooding and coastal erosion a real threat, necessitating critical calls to action. Of particular threat to the North is the destruction of its permafrost, the permanently frozen subsoil layer which can reach depths of over 300 meters and which lies beneath an "active" layer of seasonally melting ground and snow. This integral layer of permafrost acts as a binder giving structural stability and compactness to the Arctic ground plane. When it is gone, the geological makeup of the terrain is no longer intact and its structural stability compromised. In Nunavik, the northernmost third of Quebec, the permafrost is melting so quickly that airport runways, homes, and roads are starting to crumble.

With disaster comes opportunity. As the environmental crisis ensues, exploration will surpass exploitation and this inverted Polar Mediterranean will see the

opening of Canada's northernmost coastline. Environmental data is currently plotting the fluctuations of polar ice, which have previously kept the Canadian Arctic unnavigable to tourism and shipping routes by sea. Summer sea ice has receded by nearly 50% since the mid-80s, and onlookers predict that Arctic waters will be completely open within five to fifteen years.<sup>3</sup> A navigable route through previously volatile waters will open the Northwest Passage to extensive commerce and military expansion. Across this new Polar Mediterranean, shipping routes traversing the Arctic will reduce trips between Europe and Asia by 7,000 km, negating the need to detour through the Panama Canal.<sup>4</sup> As it becomes a nation "from sea, to sea, to sea", Canada will reassert itself through development initiatives. These initiatives will seek to strengthen the nation's Northern Strategy in a way that will impact and support its native population. By finding opportunity in environmental change, the Canadian Arctic has a chance to strategically reposition itself at the centre of the world map through the opening of its Arctic coastline. The mechanisms by which it develops this coastline are of fundamental and national concern, as they will present the country - and its innovative strategies of Arctic urbanism - proudly, to the world.

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<sup>1</sup> Arctic Climate Impact Assessment (ACIA). *Impacts of a Warming Arctic*. Cambridge: Cambridge University Press, 2004) 10-11.

<sup>2</sup> Myers, N., and Kent, J. *Environmental Exodus: An Emergent Crisis in the Global Arena*. Washington, DC: The Climate Institute, 2004.

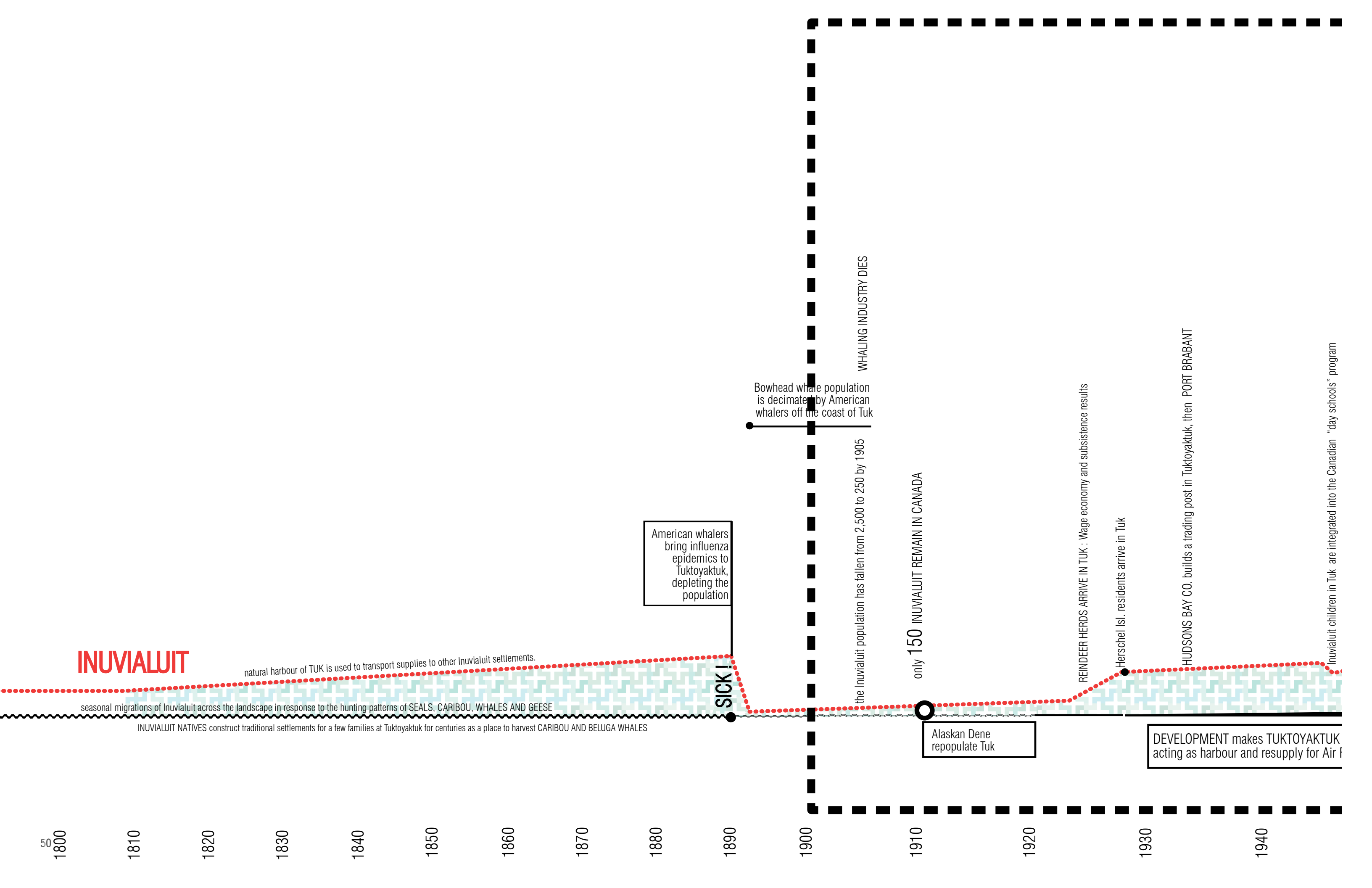
<sup>3</sup> *Arctic Sea Ice Shatters All Previous Record Lows: Diminished summer sea ice leads to opening of the fabled Northwest Passage*. National Snow and Ice Data Center, 1 Oct. 2007. Web. 24 Aug.2010. <[www.nsidc.org/news/press/2007\\_seaiceminimum/20071001\\_pressrelease\\_html](http://www.nsidc.org/news/press/2007_seaiceminimum/20071001_pressrelease_html)>.

<sup>4</sup> "Breaking the Ice: Everyone wants a piece of the Arctic." *The Economist* 19 Aug. 2004. Print edition.

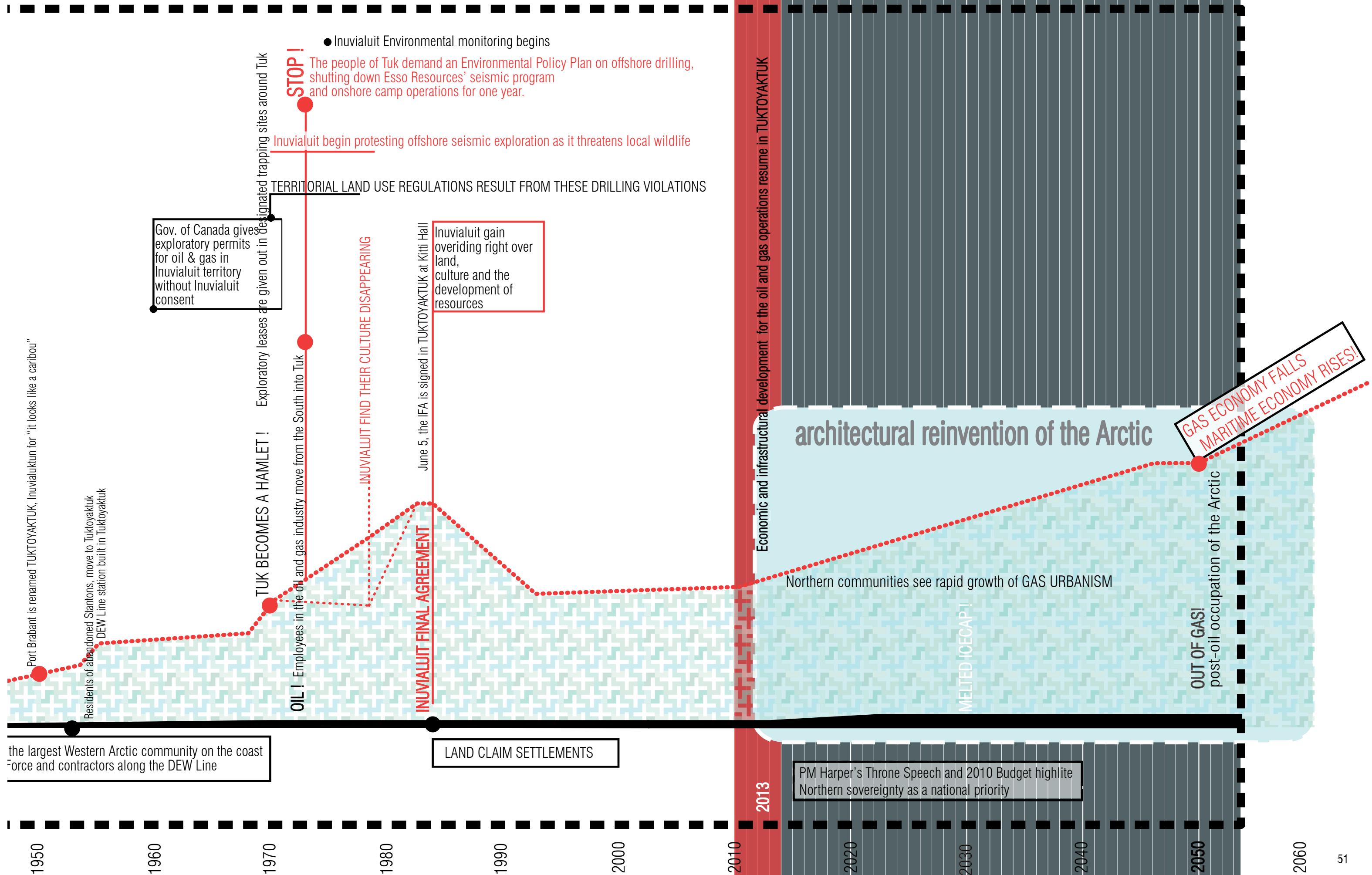


## 2. THE INUVIALUIT









The Struggle and Formation  
of the Inuvialuit Voice :

The history of the Canadian Arctic is marred by intense, far-reaching government control over the northern indigenous populations. The Inuvialuit are the Inuit people of the western Canadian Arctic, and are among the native populations that have struggled over the past century to gain and retain sovereignty over the Arctic lands. Throughout the twentieth century, a series of events occurred throughout the Northwest Territories that threatened the Inuvialuit way of life, the preservation of their cultural heritage, and the nation's recognition of and respect for the Inuvialuit's control over their own land. The beginning of the twentieth century saw an influx of whalers and traders from the south to the western Arctic, who brought with them southern goods, disease and a desire to conquer the northern territories. Peaking in the 1960s, these foreign settlers began to overpower the Inuvialuit people and threatened to assume total control over the territory. Rather than defend them in their struggle, the government of Canada exercised the belief that Britain discovered the North and therefore saw the assimilation of the Inuvialuit as the best option for national interest. Soon enough, the Catholic church had infiltrated the north, and the government had enforced the devastating Residential Schools Program in Arctic communities. Southern interest and interference in the Inuvialuit way of life continued to rise, perpetuating the threat to the local culture and the environmental stability of their land. Peter Usher noted this in his 1973 report for the Committee of Original People's Entitlement (COPE), and wrote:

The Hudson's Bay Company, the mission, the police the government, and the oil companies have always come to the North because they wanted somethign for themselves and they used their legislative and regulatory powers to get it. Always, this meant changing the Inuvialuit in some way, like getting them to follow a certain religion, or follow certain laws, or to hunt and trap for certain animals instead of others, or to speak another language, or to run their lives by a clock instead of by the sun, the weather and the seasons.<sup>5</sup>

The brief period of offshore oil and gas exploration in the Beaufort Sea in the 1970s and 1980s marked a challenging time for Inuvialuit control. With exploration licenses and business agreements flowing directly from the oil companies to the federal and provincial governments, little to no consideration was given to the effects that these oil operations would have on the Inuvialuit. Ottawa gave no consideration to the Inuvialuit way of life, has "[t]he government really only offer[ed] the native people token power."<sup>6</sup> In this way, this first wave of offshore oil explorations marked a peak in Inuvialuit struggle within

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<sup>5</sup> Ho, Zoe; Peggy Jay; Gerry Roy; and Roger Connelly.(eds) *Inuvialuit Final Agreement 25th Anniversary*. Inuvialuit Regional Corporation. IRC: 2009: 22-23.

these geopolitical battles of land and resources. In a time of foreign intrusion and a weakened state of Inuvialuit culture, the struggles of this northern population were only worsened by the Canadian government's refusal to honour and preserve their Arctic heritage.

Following several periods of neglect and mistreatment the strife reached its peak in Tuk with the commencement of offshore oil exploitations. As a result of these exploitations of access and monetary paybacks, the Inuvialuit have managed to emerge with sovereignty over their land and resources in the Inuvialuit Settlement Region. While oil explorations brought many forms of strife to the Inuvialuit, the bust and retreat of the industry also led to the signing in 1984 of the Inuvialuit Final Agreement - an agreement that gave them a voice in Ottawa and enforced their control over the region and its riches. The agreement, signed by both the Inuvialuit and the Canadian government, outlined the first land claims settlement, known as the Western Arctic Claims Settlement Act. The act's goals were to:

preserve the Inuvialuit cultural identity and values within a changing Northern society and enable the equal participation of the Inuvialuit in the northern and national economy and society that was taking shape.<sup>7</sup>

The agreement also provided the absolute title of approximately 91,000 square kilometers of land in the Northwest Territories, 13,000 of which include the title to both surface and subsurface rights.<sup>8</sup> Beyond the IFA, a land-claim and resource agreement was also reached with the federal government. The government's extension of \$17 million of national funding for social and economic development throughout the North helped to set these goals of Northern development and prosperity in motion. Having previously struggled through the boom and bust economies of resource development, the agreements of the IFA allowed the Inuvialuit to establish a resilient business sector in the face of a changing economy. The population took advantage of skills training, business mentoring and development opportunities to emerge as a largely self-sufficient, employable and successful society. The strengthening of their business skills helped the local population to actively assert their control over their land, their economy and the deployment of their Arctic infrastructure - even in the face of a rapidly changing urbanism. Indeed, while the bust of the previous oil explorations left the Inuvialuit economically stranded and seeking financial resources, it also accelerated the formation of the Inuvialuit Development Corporation (IDC) which has fostered several strong northern business enterprises that have helped to strengthen their economy and

allow them to assert their rights over their land and resources. From this newfound self-reliance came oil and gas development, air travel services, environmental services, construction, modular home manufacturing, real estate, and the development of a strong inland marine transportation company, called Northern Transportation Company Limited (NTCL). NTCL's northern hub now resides in Tuktoyaktuk where it manages the logistics of tugboats and barges transporting bulk petroleum products, dry cargo shipments and other goods to northern communities as well as facilitating the gas exploration sites of the north. Structured under the IFA, the Access and Benefits Agreements ensured that any business ventures taking place in the Inuvialuit Settlement Region must in some manner filter through an Inuvialuit-owned company. This might occur through a partnership between a foreign investor and a local business, or through directly hiring local businesses and a local workforce to undertake jobs and development in the region. These agreements ensure that foreign investors can no longer exploit the land and resources of the ISR, without benefiting and strengthening the Inuvialuit economy. Through the formation of the Inuvialuit Final Agreement and the conquest of oil and gas exploitation of their land, the Inuvialuit have managed to glean benefits, equipping themselves with a strong, business-oriented culture that allows for self-governance of the Inuvialuit Settlement Region.

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<sup>6</sup> Ho, Zoe; Peggy Jay; Gerry Roy; and Roger Connelly.(eds) *Inuvialuit Final Agreement 25th Anniversary*. Inuvialuit Regional Corporation. IRC: 2009: 23.

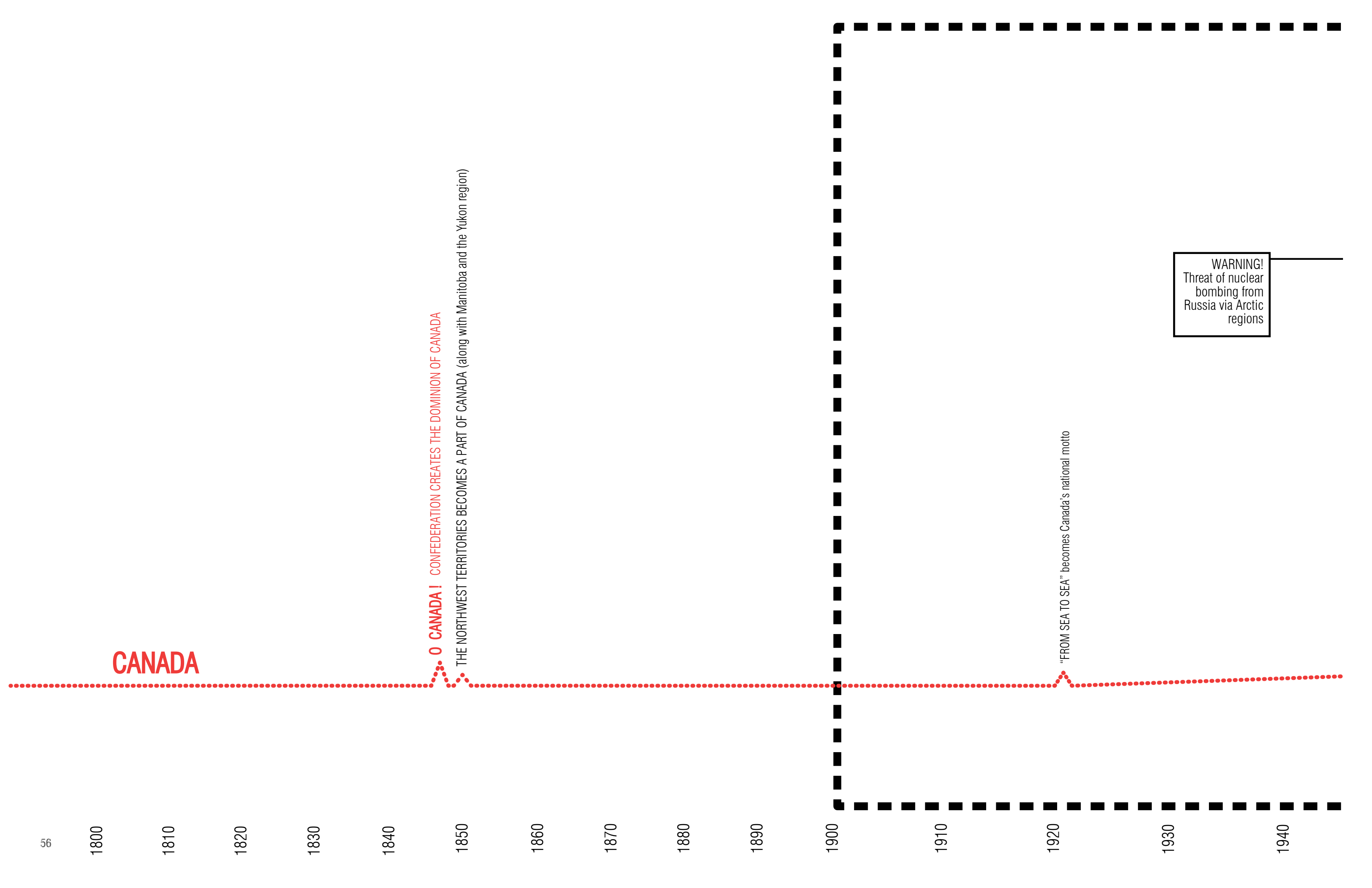
<sup>7</sup> *ibid.*: 51.

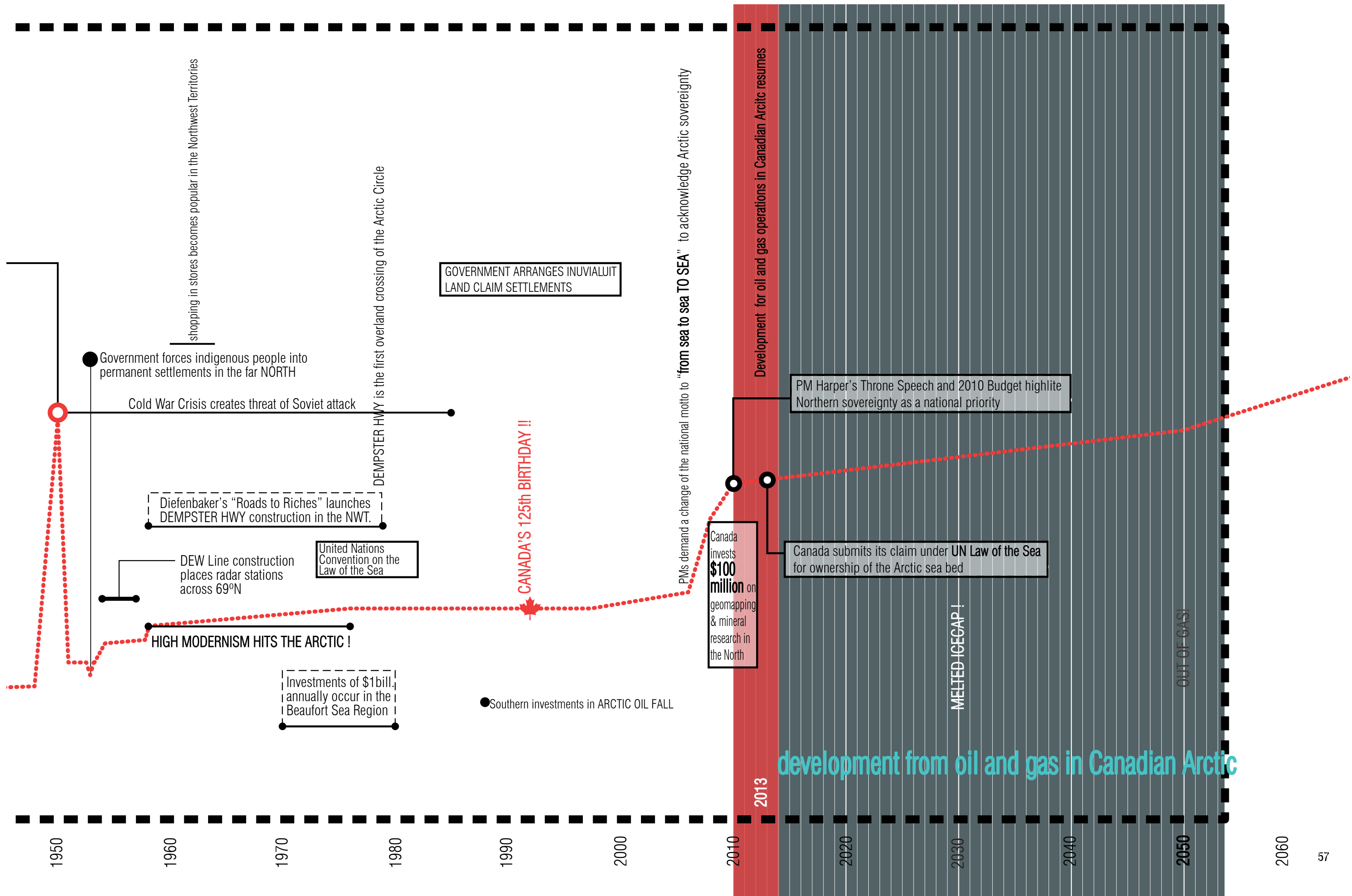
<sup>8</sup> *ibid.*: 51.

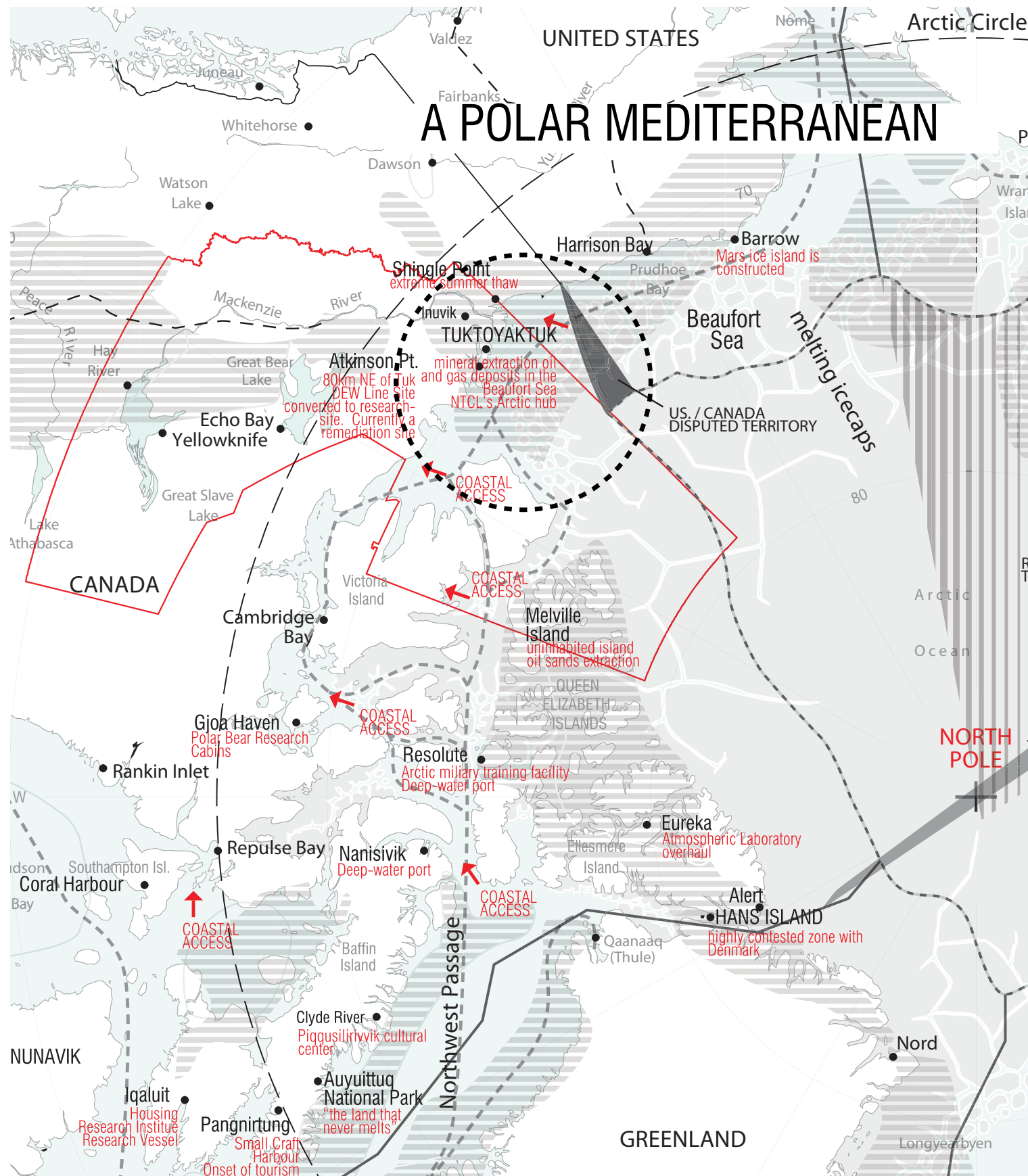


### 3. CANADA'S NORTHERN STRATEGIC DEVELOPMENT









The Canadian North:  
Strategizing an Era  
of Informed Arctic  
Urbanism

*"As long ago the Mediterranean was the most important Sea in the world because the ruling nations - Rome, Carthage and Egypt - were on its shores, so today the Polar Sea is gaining importance because the three big powers of the world - Canada as a member of the Commonwealth, U.S.A. and U.S.S.R. - are facing each other over this ice- and island-filled ocean.... The growing importance of the Polar Sea air route is influencing the development of [the North]."*

(Canadian Department of Transport. Press Release, 1957.)

At 69°27'N, the northernmost settlement on the Canadian mainland, Tuktoyaktuk's extreme location and lack of accessibility leaves it vulnerable to subjugation by the oil and gas industry. As Canada and the United States dispute the exact border between the northern limitations of Alaska and the Yukon, this zone of the Beaufort Sea emerges as a hotspot of resource potential - a region of national concern. Crippled by the geographic and economic strife that accompanies such remote contexts, the survival of Tuktoyaktuk amidst this future development will rely on the thoughtful intervention of both federal and provincial planning strategies. It is therefore critical to highlight the strengths of the federal government's incentive for Northern development. Doing so reveals that Tuktoyaktuk stands as a prime site for federal intervention and development under Canada's Northern Strategy.

In the past, Canada's northern territories have retained nearly a developing world status. Its people are crippled with an undeveloped landmass, previously inadequate shipping capabilities, a historically weak political voice, high unemployment and suicide rates, and poor access to the education systems needed train a skilled wage workforce. However, this geopolitical climate is set to change through the Canadian government's assertive plans and infrastructural promises for Northern development. These national large-scale projects provide the economic stimulus within which this thesis operates. In his 2010 Speech from the Throne, *"A Stronger Canada. A Stronger Economy. Now and for the Future"*, the Prime Minister of Canada, Stephen Harper identified Canada's Northern Strategy to be an exertion of the nation's Arctic sovereignty through various territorial, research and development projects. These range from a High Arctic research station, a small-craft harbor, a cultural facility in Clyde River, and \$90 million in economic development projects.<sup>9</sup> Within these changes, he also highlights the period of oil and gas exploration as a crucial moment of opportunity for

<sup>9</sup> *Speech from the Throne. A Stronger Canada. A Stronger Economy. Now and for the Future.* Canada: Library and Archives Canada Cataloguing in Publication, 2010.

northern development. Harper states that the

“likely expansion of the workforce in the region, and the movement of greater numbers of newcomers into the north to engage in these new opportunities will impose added pressures on local communities... It will require extraordinary effort and careful planning and management to ensure that the new and expanded economic activities are sustainable and are pursued in a manner that minimizes the damage to the environment” and existing communities.<sup>10</sup>

By focusing on the period of offshore oil development that is upon us, this thesis will reinforce the goals of Canada’s national plan, through its development of a strengthened Arctic infrastructure. Canada is aligned to execute an insightful, informed strategy for Arctic urbanism in Tuktoyaktuk, allowing it to serve as a model for Arctic development through strategic shared partnerships of this type. In order to accomplish this, infrastructural development must take advantage of the unique overlapping of interests that will include huge, finite investments from the oil and gas industries spilling into this remote northern settlement. It is critical that the government recognizes that this shared interest in development - if strategized correctly - has the ability to accelerate key areas of their Northern Strategy. Certain industry needs, as witnessed in Tuktoyaktuk’s boom in the 1980s, can have a profound influence on the development of the nation’s Northern population and the infrastructure that constructs the Arctic urban environment. For example, increased access to skilled labour holds strong promise for the development of Northern education and training centres that will teach and certify a largely unskilled ,but highly capable Northern workforce. Similarly, the ability to tie the nation’s Arctic environmental and ecological research into the environmental testing of the industry is another key area of overlap. In 2007-2008, Canada’s made one of the highest contributions of any nation to the International Polar Year, a global program dedicated strictly to polar research. By piggy-backing on the advanced, ecological testing required by industry standards, this body of knowledge could increase even further, allowing Canada to become a leader in Arctic research. Certain exerpts from Canada’s Arctic Foreign Policy help to understand the potential of this unique Arctic development opportunity:

- Canada will show leadership and work with others to demonstrate responsible stewardship to build a region responsive to Canadian interests and values, secure in the knowledge that the North is our home and our destiny.
- Canada will maintain control of our Arctic lands and waters and will RESPOND when others take actions that affect our national interests

see history of Arctic Urban-  
ism on pp82-91

- Canada will be seeking trade and investment opportunities that benefit Northerners and all Canadians and encouraging a greater understanding of the human dimension of the Arctic to improve the lives of Northerners.
- Canada is contributing to and supporting international efforts to address the causes and effects of climate change in the Arctic.  
(From Canada’s Arctic Foreign Policy Statement: [www.circumpolar.gc.ca](http://www.circumpolar.gc.ca))

In this way, a period of great social and economic development is upon Canada, during which they have the chance to attack their goals for Northiern development through the strategic alignment with the oil industry.

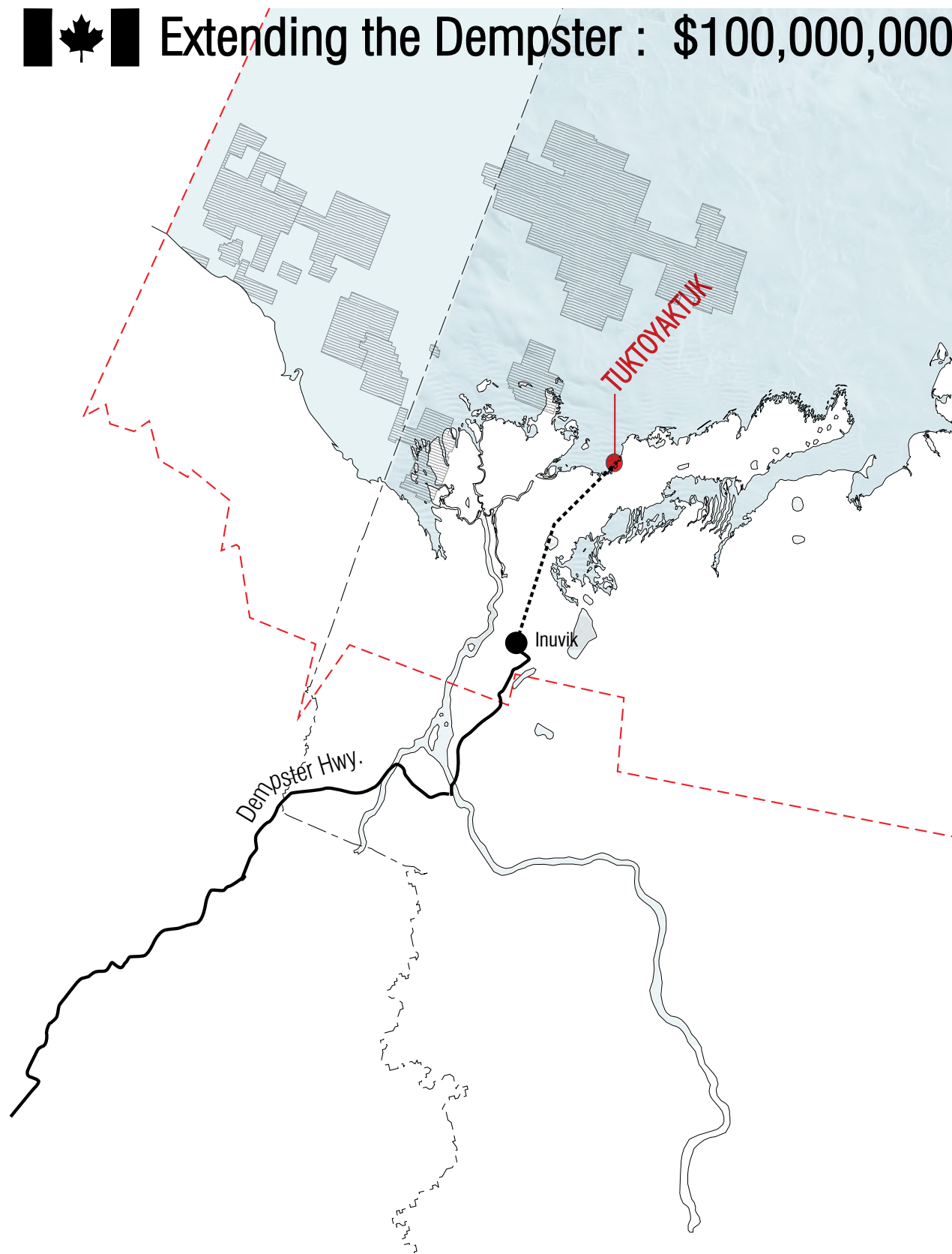
While these claims might bear a familiar resemblance to previous attempts at exerting utopic national plans for modernizing the North, this period of Arctic urbanism emerges from nearly a century of harsh lessons, and is uniquely facilitated by the huge financial backing from the oil industry. Through this economic opportunity, Canada sits in a strategic position to make-right their failed northern strategies of the past. They have a unique opportunity to materialize some of the ideations on Northern identity that have been in discussion since the 20<sup>th</sup> century. As stated by John Diefenbaker, Prime Minister of Canada who was strategically concerned for Arctic resources, “[A] national development policy will create a new sense of purpose and national destiny... I see a new Canada – a Canada of the North,” that will give Canadians “a transcending sense of national purpose...safeguard our independence, [and] restore our unity.”<sup>11</sup> In the nature of such unity, the era of Arctic urbanism addressed by this thesis seeks to accommodate and synchronize the various overlapping opportunities acting in the first half of the 21<sup>st</sup> century. It is in these opportunities and crises that a strengthened Arctic urbanism can be designed for Canada’s North.

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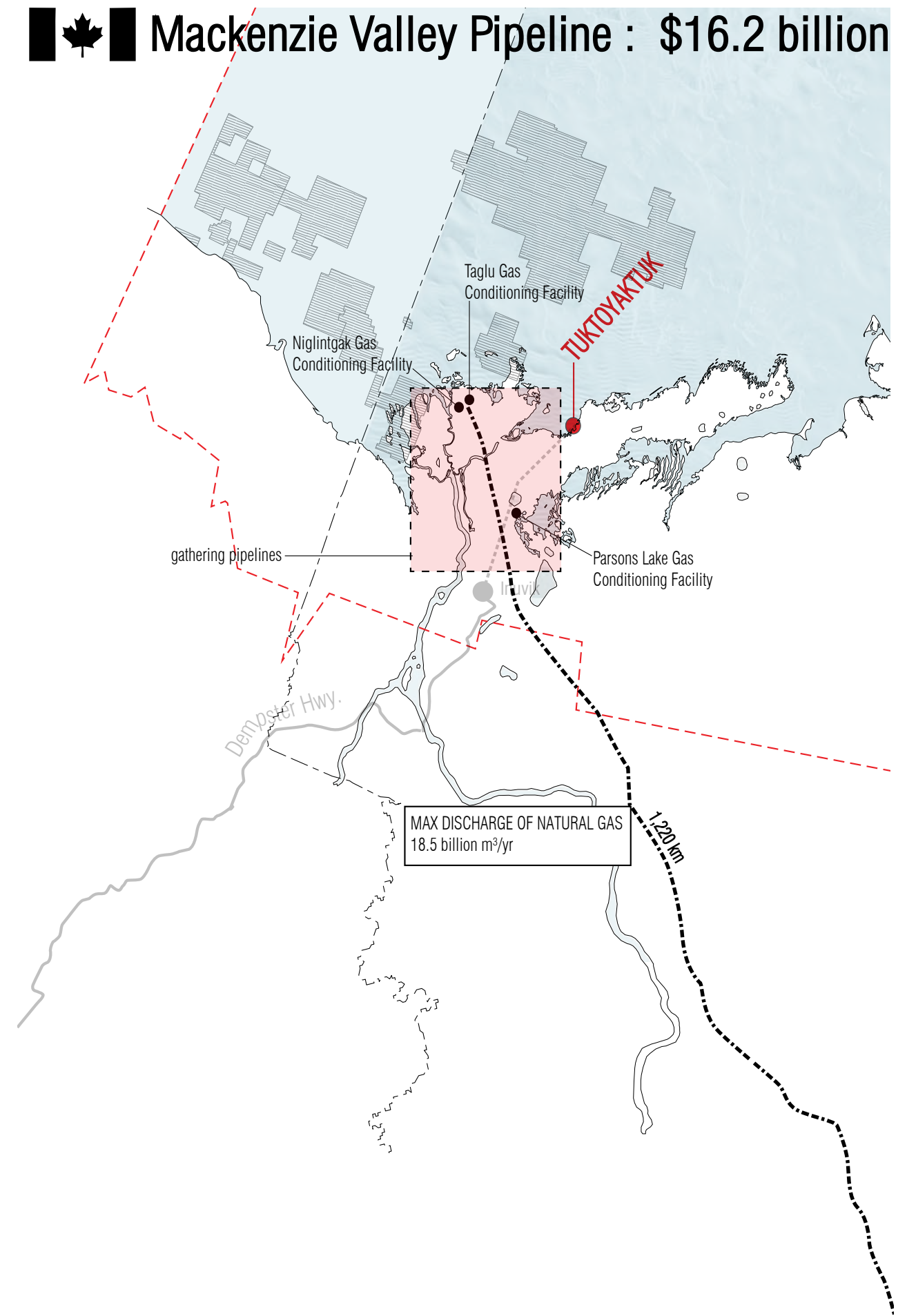
<sup>10</sup> Hubert, Dr. Rob and Yeager, Brooks B. *A New Sea: The need for a Regional Agreement on Management and Conservation of the Arctic Marine Environment*. Oslo: WWF International Arctic Programme. 2008.  
<sup>11</sup> Benedickson, J. *The Canadian North. Source of Wealth or Vanishing Heritage?* Prentice Hall Trade, 1977. 160-62..



■ ■ **Extending the Dempster : \$100,000,000**



■ ■ **Mackenzie Valley Pipeline : \$16.2 billion**





## CANADA'S POLAR MEDITERRANEAN

strategizing an Arctic sovereignty



“Through its comprehensive NORTHERN STRATEGY, the Government is making progress to **help the North realize its true potential** as a healthy, prosperous and secure region within a strong and sovereign Canada. “

“taking a historic step toward making Canada more competitive in the GLOBAL ECONOMY.”

**Budget 2010** will provide:

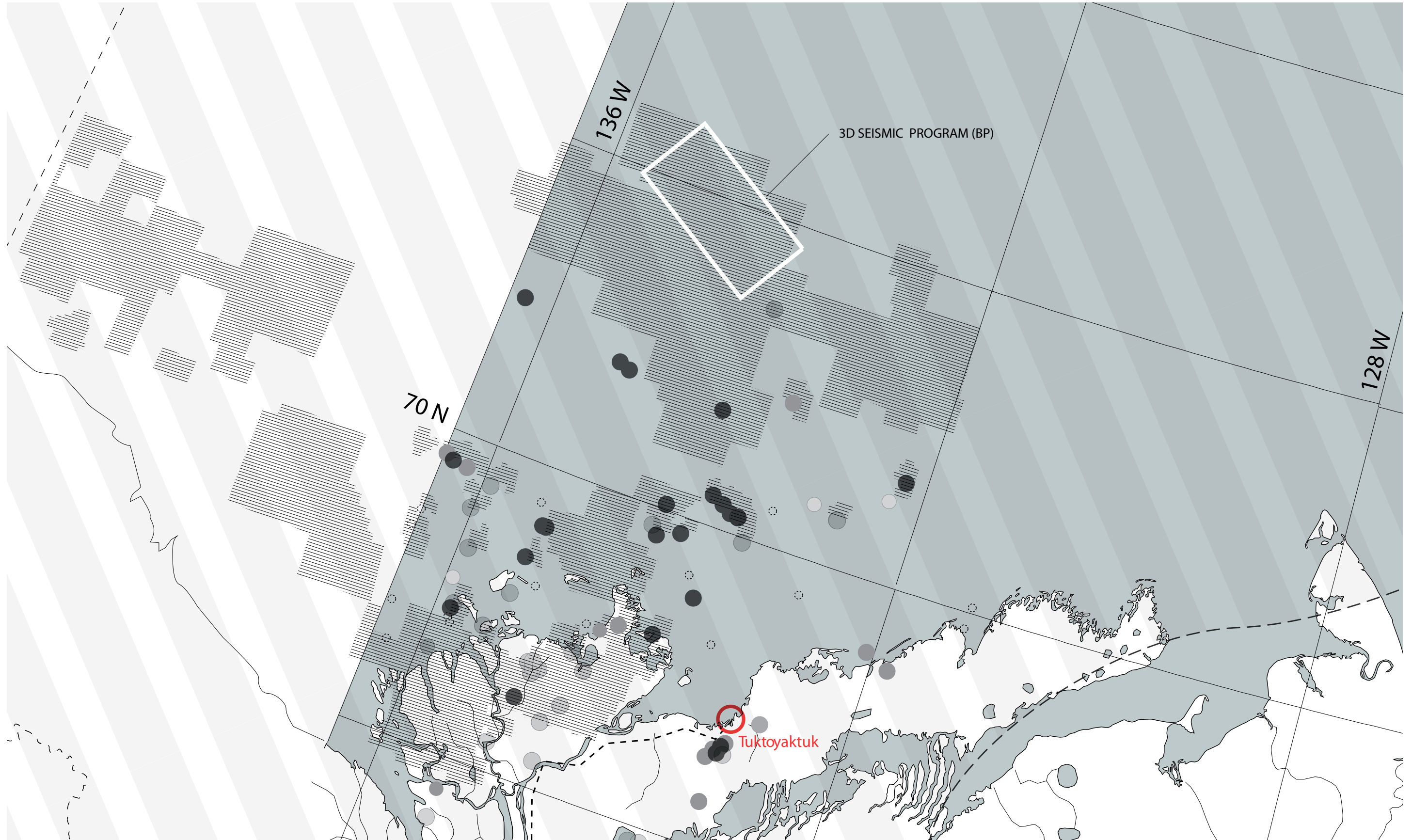
\$331 mill. to improve First Nations infrastructure  
 \$85 mill. to Arctic Research Infrastructure  
 \$20 mill. to strengthen Northern economic development  
 \$200 mill. for Northern social housing  
 \$8 mill. for Indian and Northern Affairs Canada to support community-based environmental monitoring, reporting and baseline data collection

(From: Budget 2010)

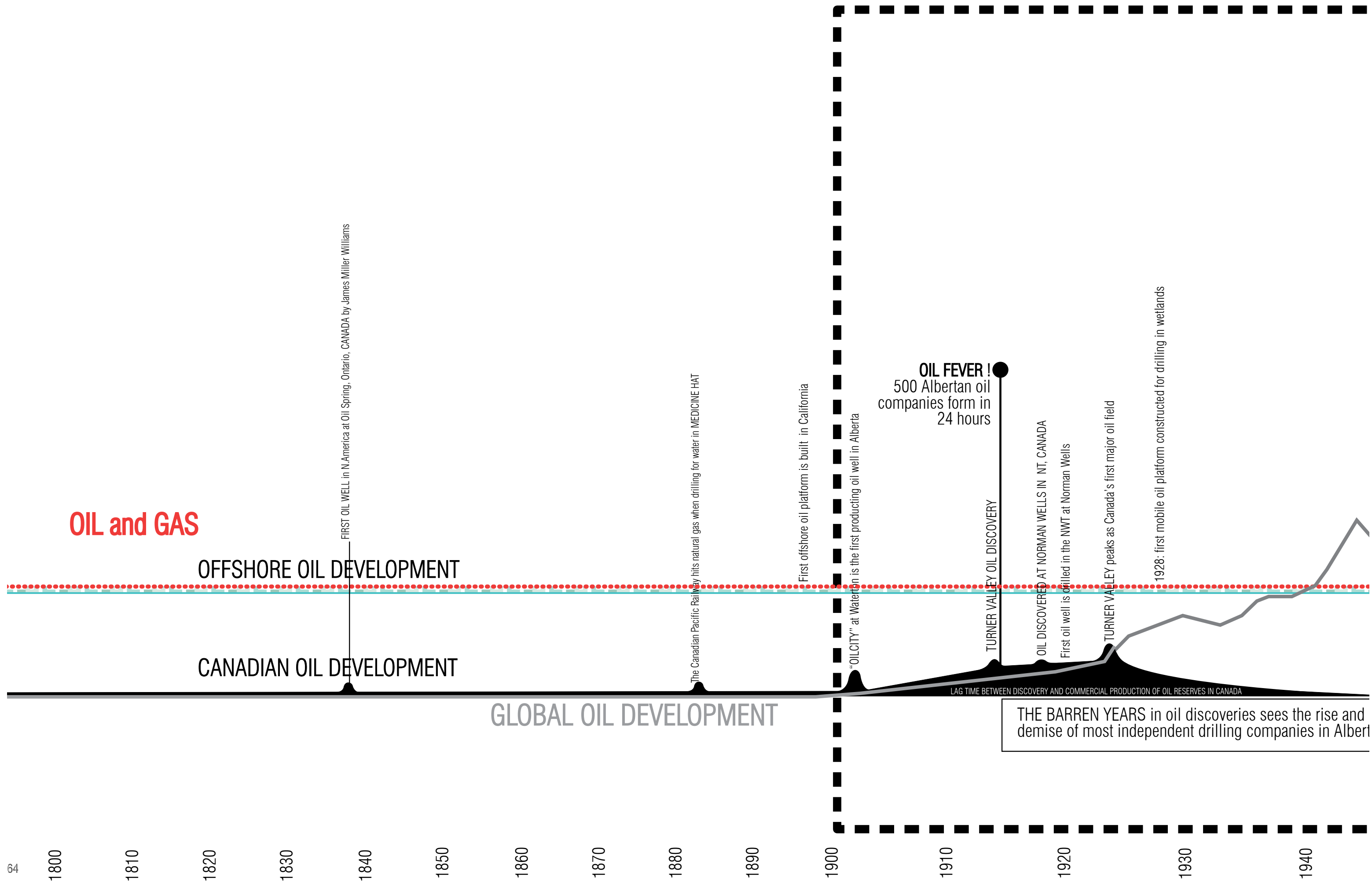
**BUT...  
WHAT IS REACHING TUK ?**

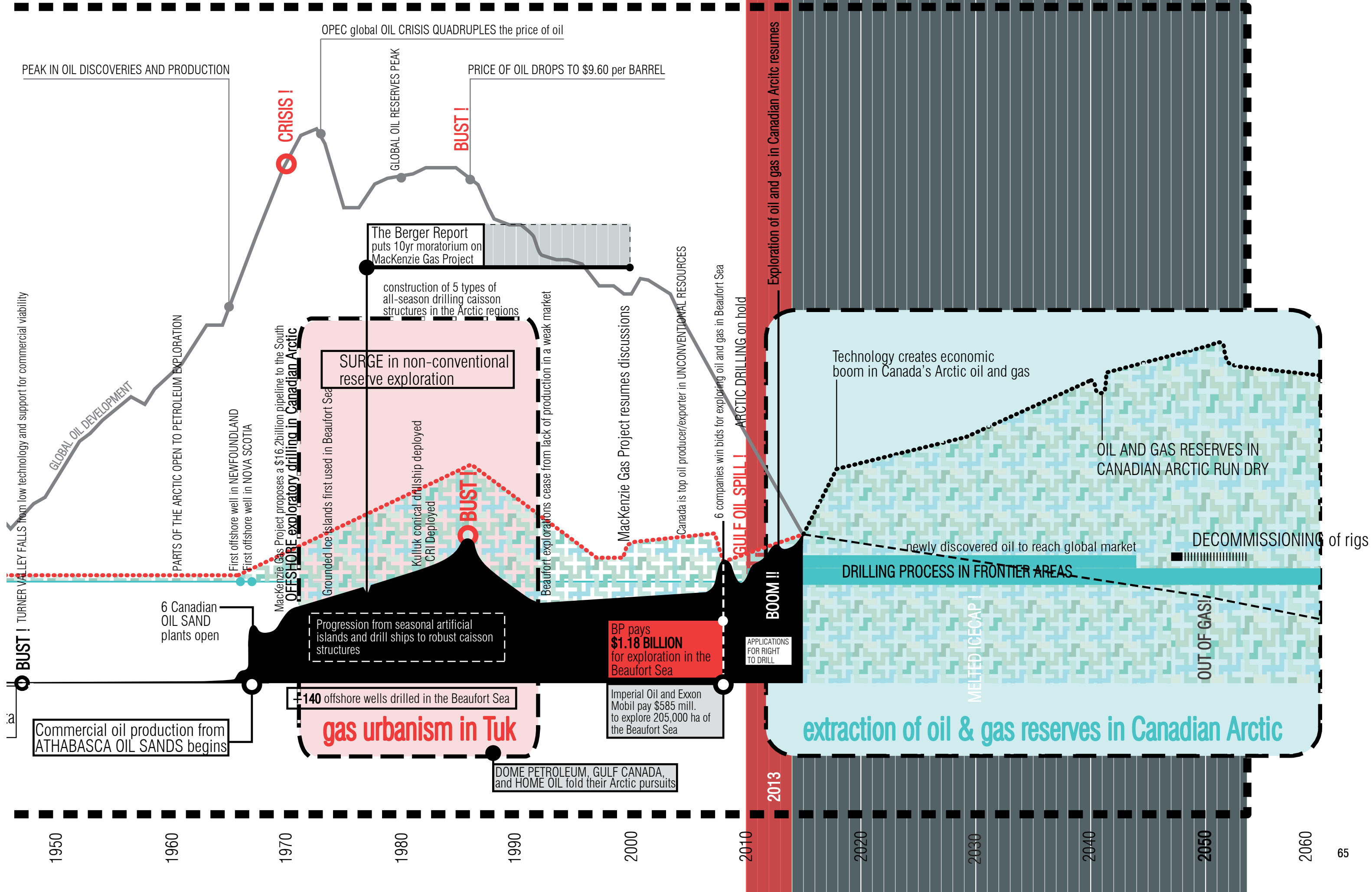
POLICY DRIVER	FUNDING PROGRAM/ACTIVITY	INVESTMENT (\$)	TIMEFRAME	OTHER INFORMATION
Support for Canadians and Their Families - Budget 2006	Northern Housing Trust	\$300 million = \$50 Northwest Territories \$50m Yukon \$200 Nunavut	One-time payment	Paid into a third-party trust
A Vision for a New North - Supporting Fisheries in the North - Budget 2008	Commercial harbour in Pangnirtung, Nunavut	\$8 million	Over 2 years	Construction, operation and management costs of the initiative
A Vision for a New North - Protecting and Securing Canada's Sovereignty - Budget 2008	A new polar-class icebreaker	\$720 million	-	For procurement of new vessel, given decommissioning of Canadian Coast Guard's current icebreaker in 2017.
Action to Stimulate Housing Construction - Budget 2009	Northern housing	\$200 million = \$50 Northwest Territories \$50m Yukon \$100 Nunavut	Over 2 years	Funding provided through the Canadian Mortgage and Housing Corporation.
Immediate Action to Build Infrastructure - Supporting Canada's Vision for the North - Budget 2009	Building a worldclass hig Arctic research station	\$87 million	Over 2 years	To maintain or upgrade research facilities; to be completed by March 31,2011. \$2 million for Indian and Northern Affairs Canada for feasibility analysis of station.
Immediate Action to Build Infrastructure - Small Craft Harbours - Budget 2009	Construction of Pangnirtung Harbour in Nunavut	\$17 million	-	-
Building Canada Plan - Budget 2009 and earlier budgets	Canada-Yukon Framework Agreement	\$274.61 million	Over 7 years (2007-2014)	Includes Building Canada Fund Territorial base fund Gas tax fund Municipal rural infrastructure fund
-	Canada - Northwest Territories Framework Agreement	\$277.5 million	Over 7 years (2007-2014)	Includes Building Canada Fund Territorial base fund Gas tax fund Municipal rural infrastructure fund
-	Canada - Nunavut Framework Agreement	\$274.28 million	Over 7 years (2007-2014)	Includes Building Canada Fund Territorial base fund Gas tax fund Municipal rural infrastructure fund

Source : Government of Canada budget documents available on the website of the Department of Finance.  
 Retrieved from: <http://www.nrtee-trnee.com/eng/publications/true-north/chapter7-true-north-eng.php>



## 4. OIL & GAS DEVELOPMENT









Gas Urbanism in Tuk :  
A Case of the  
1970s and 80s

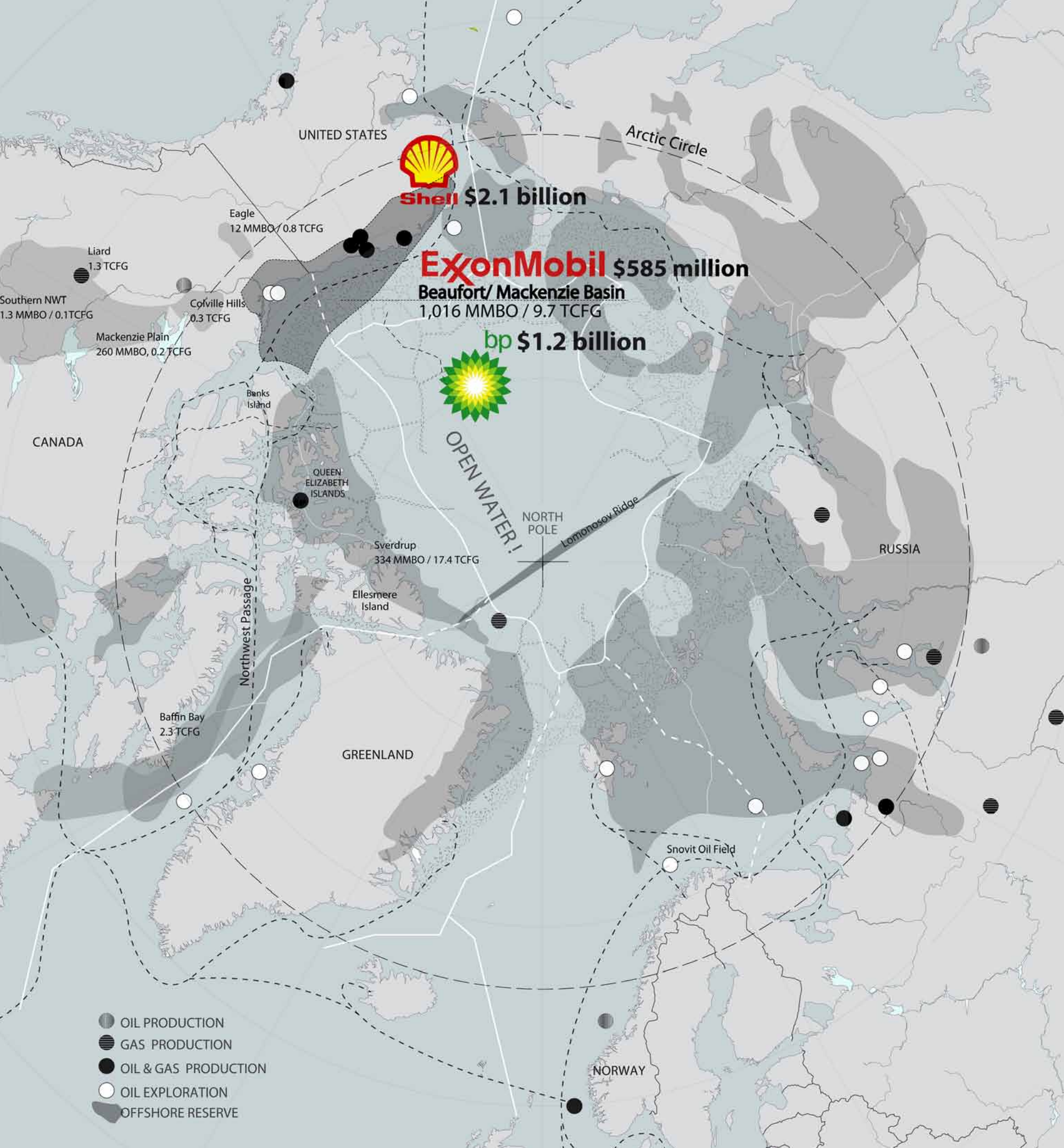


The viscous Arctic landscape is slowly slipping out from under its communities, while huge infrastructural projects for hydrocarbon extraction simultaneously begin to construct a new Arctic urbanism. As the world consumes two barrels of oil for every barrel discovered, the once-frozen Arctic is launched into hot pursuit of rapid gas urbanism and dropped into the centre of the global gas economy. According to the U.S. Geological Survey, the Arctic Circle holds an estimated 90 billion barrels of undiscovered, technically recoverable oil and 1,670 trillion cubic feet of natural gas. They claim that the Arctic accounts for about 13% of the world's undiscovered oil, 30% of the undiscovered natural gas, and 20% of the undiscovered natural gas liquids.<sup>12</sup> As much of the world's most easily accessible resources have nearly run dry, exploration shifts towards untapped resources in locations previously avoided as either ecologically or politically sensitive territories. In this way, both the high prices of oil and the thinning of the ice caps foster the ability to pursue more costly technologies required to access these resources. And they have begun to do so. Examples of such rapid infrastructural pursuits occurring under the veil of oil and gas development already exist in Canada's Arctic past. In the Mackenzie region, a significant leap has already been made towards the onset of exploratory drilling and processing. One can notice a rapid drilling lineage where, in 1900 zero wells had been drilled in the ice off the shores of the Arctic, a count which soon became 100 wells in 1950. With 394 offshore wells drilled in 1970, an exponential leap occurred in the next twenty years as 1990 housed 1,165 wells in the Mackenzie region alone. While the history of offshore oil development in Tuktoyaktuk will be discussed in the following chapters, it is important to note here that with predictions of housing up to 72 billion barrels of oil, companies such as BP and Shell are positioning themselves for exploration in this contested subterranean territory. As such, Tuktoyaktuk is on the forefront of experiencing an explosion of oil and gas exploration. This surge will be witnessed onshore through the development of required services and facilities that support offshore pursuits.

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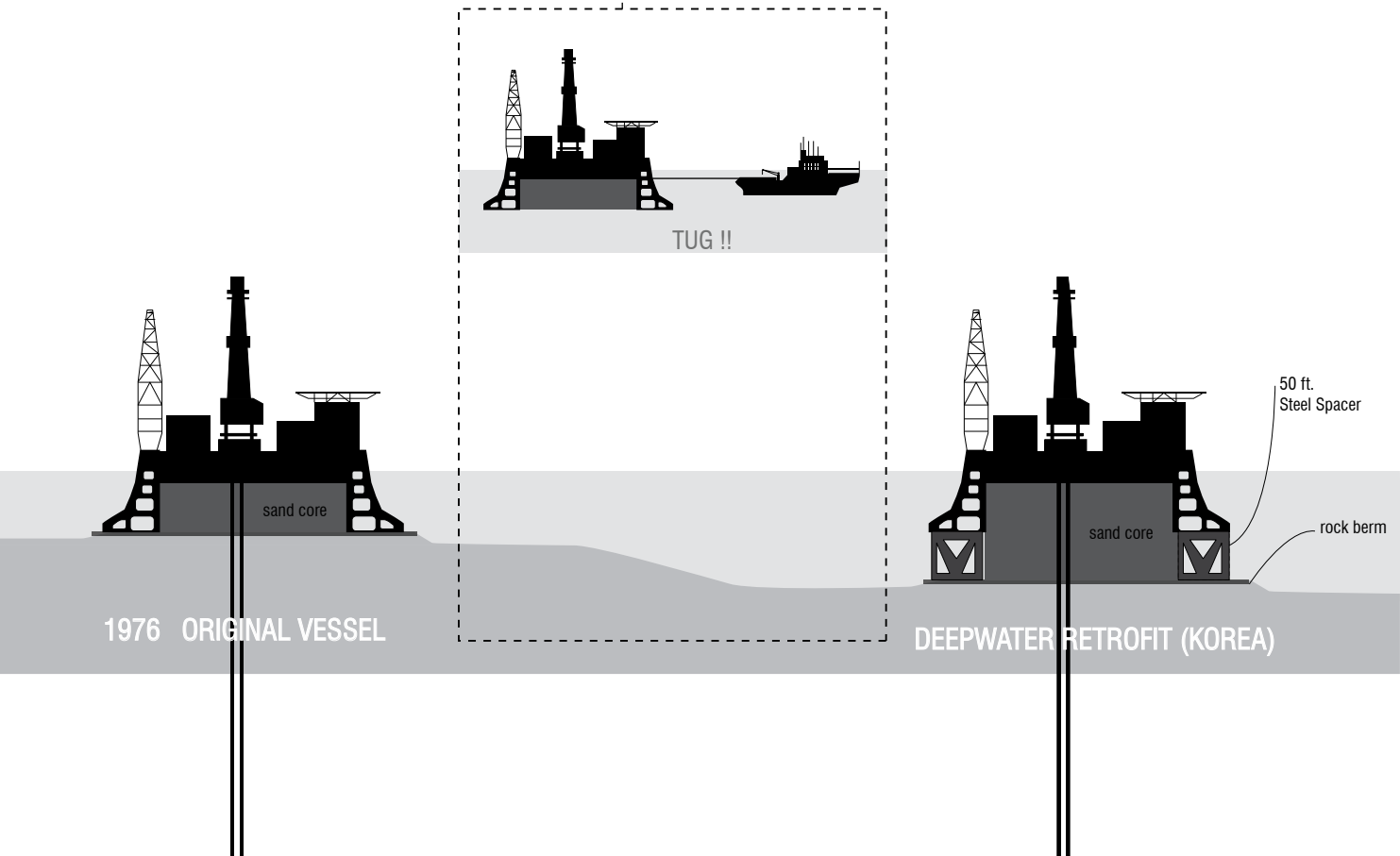
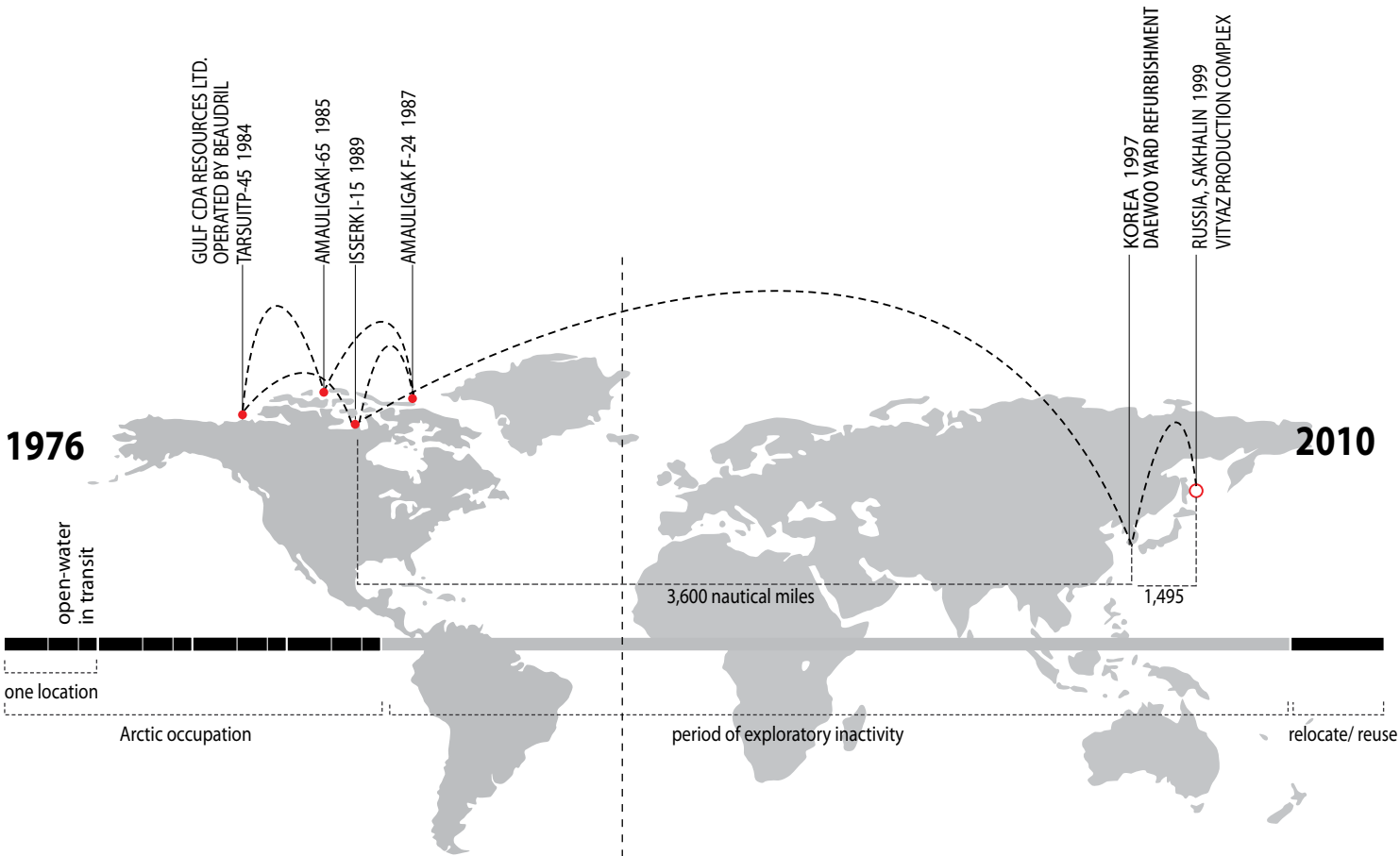
<sup>12</sup> United States Geological Survey,(USGS). *90 Billion Barrels of Oil and 1,670 Trillion Cubic Feet of Natural Gas Assessed in the Arctic*. USGS. 27 July. 2008. Retrieved 24 Aug.2010.



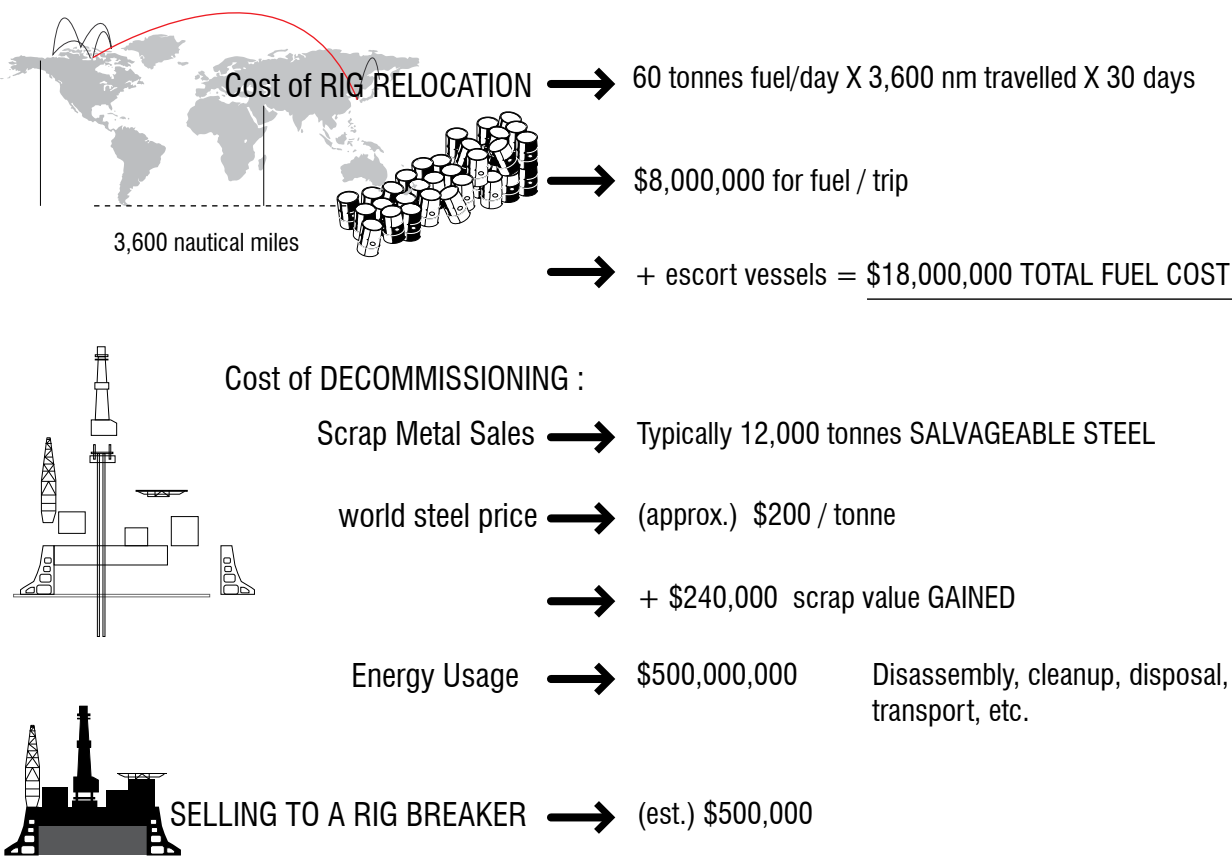


With predictions of housing up to 72 Billion barrels of oil, companies such as BP and Shell position themselves for exploration in this contested subterranean territory. Tuktoyaktuk will experience an explosion of oil and gas exploration seen through the construction of onshore facilities and support services

VESSEL ASSETS : MOLIKPAQ, Mobile Drilling Unit : 80s Retrofit and Reuse



THE COSTS OF VESSEL OWNERSHIP

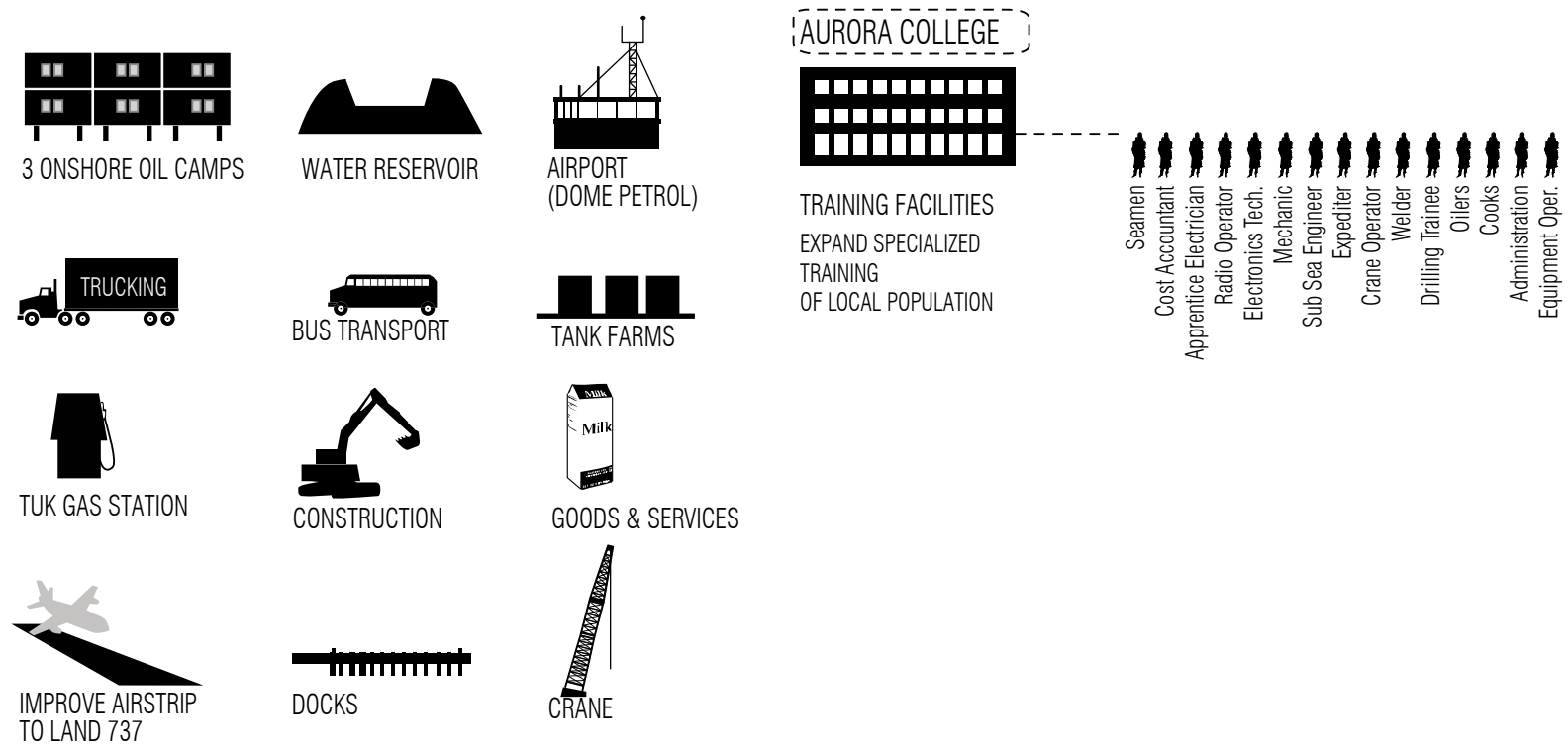


BIG MONEY INVESTED IN FLEETING INFRASTRUCTURAL ASSETS : HOW TO DIRECT MONETARY OPPORTUNITIES ?

The Canadian Arctic experienced a period of exploratory drilling following the global oil crisis of 1973. This excitement rapidly commissioned the construction of floating rig structures built to withstand the extreme Arctic conditions. With only 100 days of open water in which to drill, these ships would remain unfeasibly inactive in one location. As a result, they were shipped between drilling sites throughout the narrow windows of seasonal fluctuations, to make the most of open waters. In this way, a mobile, adaptable infrastructure was born.

1980s RAPID DEVELOPMENT OF GAS URBANISM IN TUKTOYAKTUK

ONSHORE COMMUNITY DEVELOPMENT AND ECONOMIC BOOM



1980s : RAPID DEVELOPMENT OF GAS URBANISM IN TUKTOYAKTUK



SEISMIC AND GEOPHYSICAL DATA COLLECTION



SEISMIC VESSEL  
self-sufficient vessel

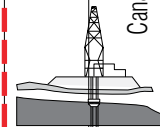


SUPPORT VESSEL  
moves between Seismic Vessel and Tuktoyaktuk to transport supplies, equipment, people and fuel.



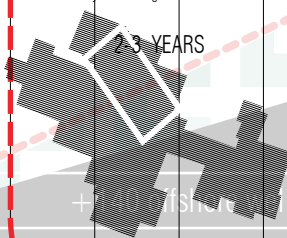
PICKET VESSEL  
equipped with radar to detect other marine traffic

Canadian Government issues "Approval-in-Principle" for exploratory drilling in the Beaufort Sea  
\$2 million spent by industry on research into Arctic offshore oil and gas exploration



SUBSEA PERMITS AND SEISMIC  
locate and analyze oil and gas reservoirs.

2-3 YEARS



Offshore wells drilled in the Beaufort Sea

Progression from seasonal artificial islands and drill ships to robust caisson structures

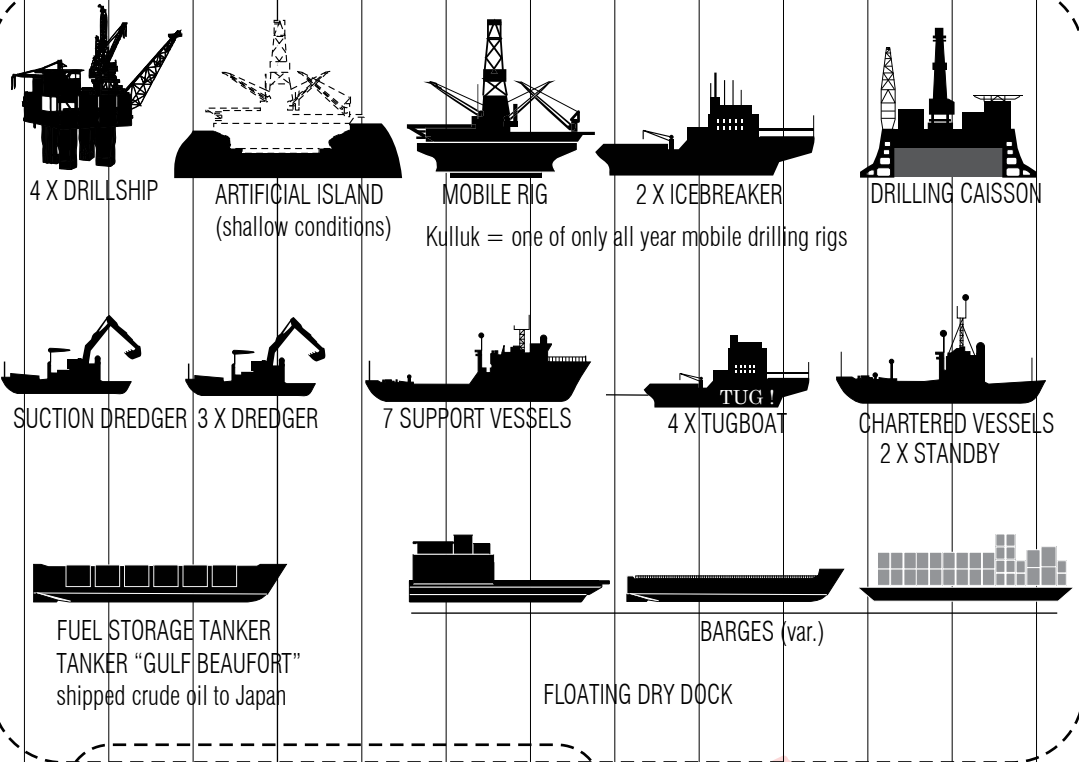
OFFSHORE EXPLORATORY DRILLING  
operable only during short 3 month open water season



ADVANCED VESSEL FLEET :

5-YEAR CANMAR DRILLING PROGRAM FROM DRILLSHIPS

construction of 5 types of all-season drilling caisson structures in the Arctic regions



VS. 39 MARINE UNITS DEPLOYED IN THE BEAUFORT SEA  
27 MARINE UNITS IN CANADIAN ARMED FORCES

BUST ! PRICE OF OIL DROPS TO \$9.60 PER BARREL

BUST !

OFFSHORE SITE DEVELOPMENT

construction of the production wells and the production facilities  
most labour-intensive phase

OFFSHORE OIL PRODUCTION

ABANDONMENT RECLAMATION

50 YEARS (ARCTIC FRONTIER AREAS)

xxxxxx YEARS

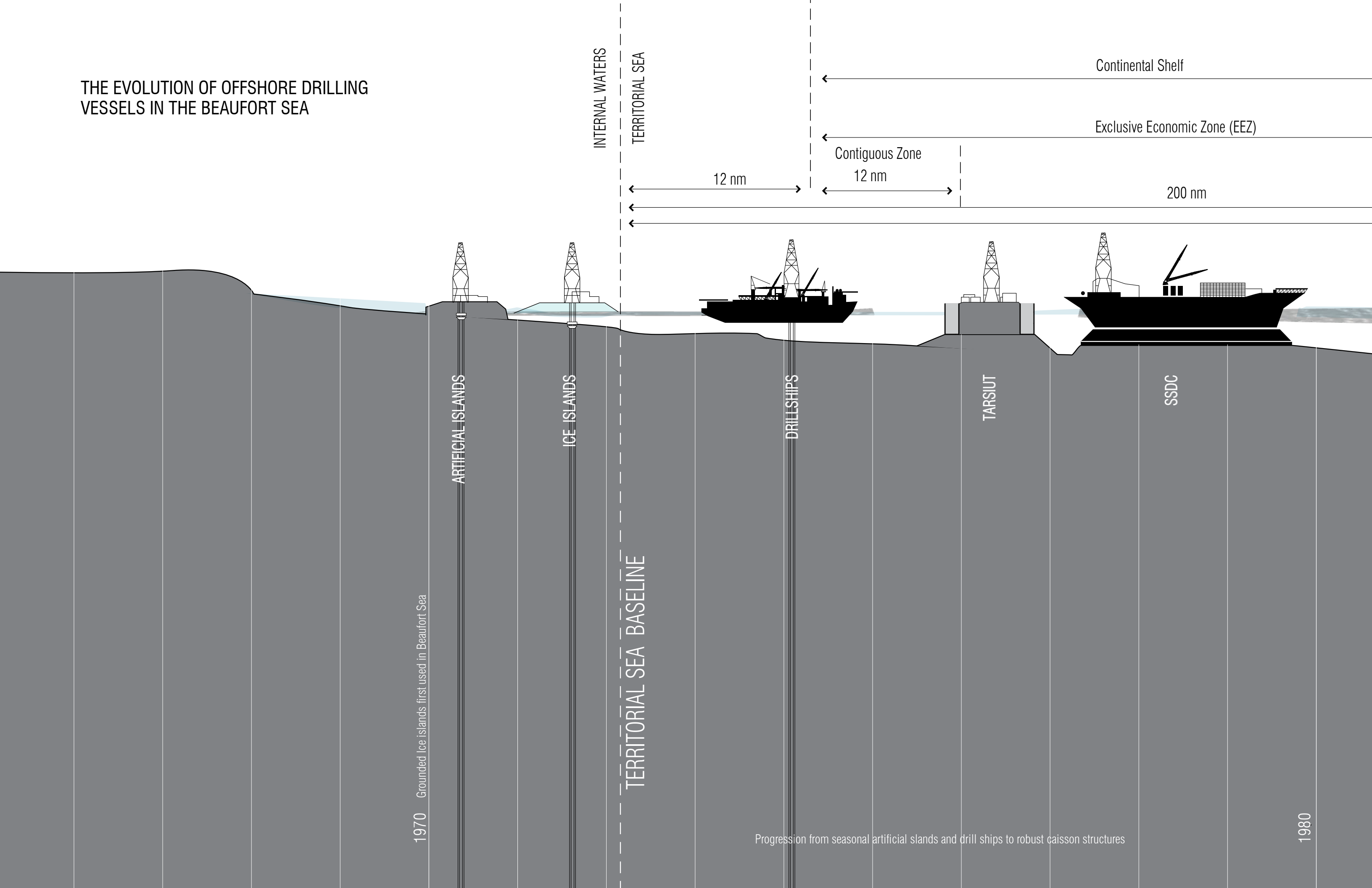
Oil Companies like DOME PETROLEUM, GULF CANADA, and HOME OIL, go out of business, folding their Arctic pursuits.

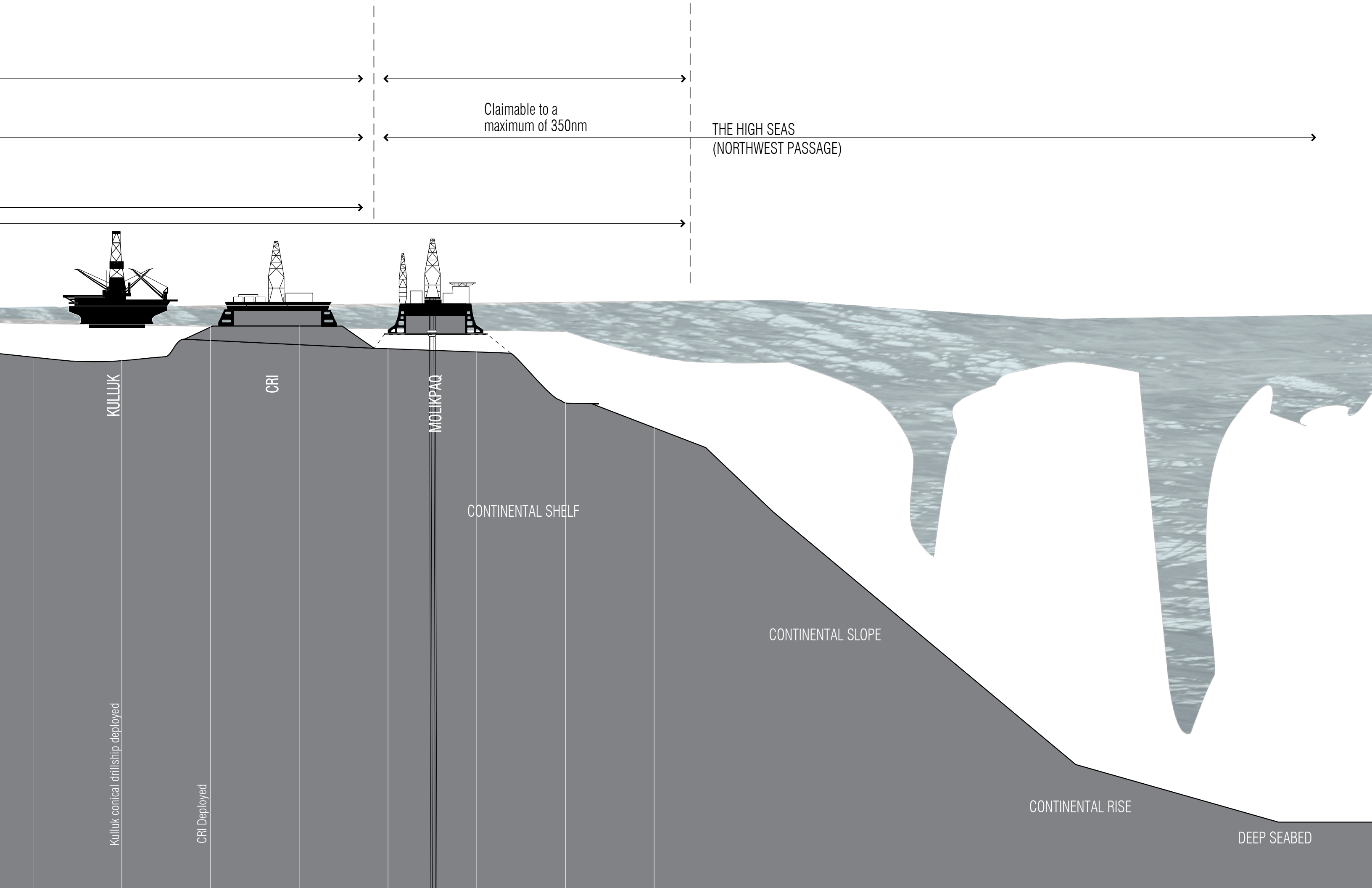
Southern investments in OIL development fall putting a HALT on unconventional, highly expensive Arctic production endeavours

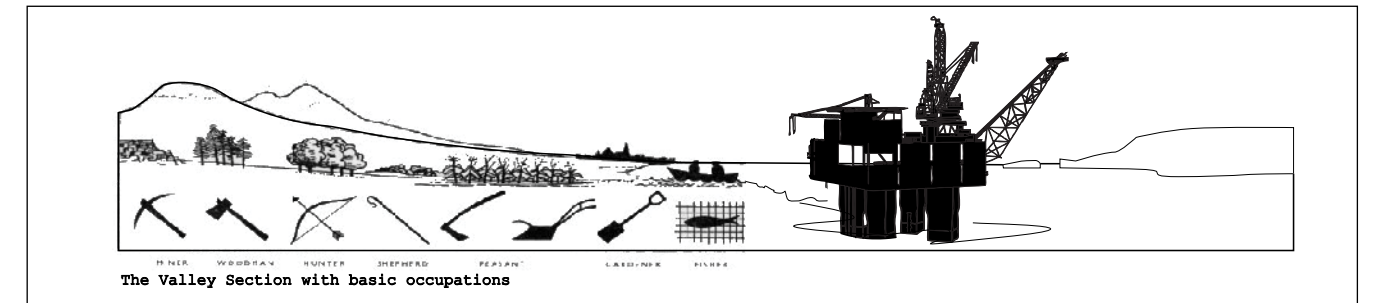
Beaufort Sea explorations cease, holding no economic viability for production in a weak market

Offshore operations in Tuktoyaktuk in the 1970s and 1980s commissioned the development of a significant vessel fleet to operate the offshore waters. A huge infrastructural feat, this deployment was largely matched with onshore development of support services, warehouses, offices and camp facilities. This fleet drastically expanded the infrastructure of Tuk.

THE EVOLUTION OF OFFSHORE DRILLING  
VESSELS IN THE BEAUFORT SEA







## Gas Urbanism And The Rise Of The Global City

The quest for fossil fuels has a history of evoking crisis, swaying governments, and launching communities into capitalist-driven eras of development. In this climate, a contemporary form of the company town is looming within the formation of Arctic urbanism. It is one which sees a temporary infrastructural and economic surge as the petroleum-based economy rapidly flows in and dominates the lands adjacent to offshore reserves. Extracting their resources and uprooting their economy, it then retreats nearly as quickly as it arose. The community that remains must face the new, unfamiliar, and abandoned urban morphology: the urban corpse.

Prior to such rapid exploitative urbanism, Patrick Geddes' Valley Section demonstrates an evolution of the history of human settlements as they are integrally linked to economy, commerce and the surrounding terrain. At the origins of contemporary discussions on landscape ecologies, Geddes demonstrates the connection between the fabric and form of settlements and the characteristics of the region from which they arise. However, the new global economy has shifted focus away from the connection between urban form and geographic setting. Cities are expanding under new environmental conditions that are decentralized, non-physical and diffuse - those which do not favor a connection to the terrain. The post-metropolis city, described by Soja, uncovers the inadequacy of the prescriptive models of regional urban form that are generated by metropolitan discourse. He states that contemporary challenges of emerging urban phenomena relate no longer to local, but instead to global challenges whose causalities are difficult to chart. Such challenges can be of the environment, transportation, and energy issues. Saskia Sassen refocuses discussions of the global city saying:

The combination of spatial dispersal and global integration has created a new strategic role for major cities. Beyond their long history as centers for international trade and banking, these cities now function in four new ways: first, as highly concentrated command points in the organization of the world economy; second, as key locations for finance and for specialized service firms,

which have replaced manufacturing as the leading economic sector; third, as sites of production, including the production of innovations produced...Cities concentrate control over vast resources while finance and specialized service industries have restructured the urban social and economic order. Thus a new type of city has appeared. It is the global city. Leading examples now are New York, London and Tokyo.<sup>13</sup>

In this global city, human settlement is founded on new migration patterns, weakened national boundaries and a heightened exchange between global cities acting as points within a larger network. In this way, a new Arctic urbanism fueled by global economics and consumerist pursuits is “marked by hitherto unimagined fragmentation; by immense distances between its citizens, literal, economic, cultural, social and political; and by novel planning problems, which raise the stakes for, and may very well demand changes in the way we think about urban planning itself.”<sup>14</sup> With expanding urbanism and exploration, the North will soon experience a rise in infrastructures that serve their expanding economies so that they coexist with and alter the permanent settlements of the Inuvialuit. Eco-tourism and other attractions of the global city will be on the rise as modes of transportation connect the Arctic more fully to the rest of the world. As well, the construction and operation of oil rigs present with their own temporality. The gas infrastructures themselves are occupied on a supply-based lifespan, lasting only until the oil runs out, at which point discussions on decommission begin. Moving onshore, structures of gas urbanism will serve the extraction, processing and distribution of these resources to the South. Simultaneously, they house a transient staff whose shift-work and short-term housing needs fluctuate along with their urban economy, exiting entirely when the resources run dry.

Cities grown out of the fossil fuel economy is not a new concept. Los Angeles serves as an example of a city that formed its identity through the rapid growth of gas urbanism and decentralization through the expansion and exploitation of the oil industry. With the discovery of the “Los Angeles City Field” in 1892, LA formed its identity for fostering industrial activity as it generated rapid offshoots of manufacturing, storage and shipping throughout the region.<sup>15</sup> Most significantly however, it led to the formation of LA’s urban image of bright lights, widespread automobile ownership, and urban sprawl. From offshore, artificial islands to camouflaged onshore extraction sites embedded in the city and underneath golf courses, LA’s quest to mask and segregate its fossil fuel pursuits led to ambitious infrastructural growth. Ultimately, however, given the temporal vulnerabilities of the oil industry and its rapid consumption in the 70s, LA came to rest

in a post-industrial identity with the end of its gas urbanism boom.

These discussions describe the urban situation that results from a rapidly influential global economy in which a city’s economic role affects both its land uses and how it emerges spatially. In the post-metropolis condition, new urban patterns emerge that are both geographic and spatial. This is demonstrated through edge-cities, fractal cities, and archipelagos. Mason White places the “thawing geographies” of the arctic into this post-metropolitan discourse as he notes how the global quest for hydrocarbon exploitation has led to the hyperactive economic and geographic development of various regions of the North. The competition of global cities through resource accumulation has spearheaded the emergence of a northern “gas urbanism” that is taking shape in some of the world’s most imposing structures, such as infrastructural megaprojects, enclave cities, and offshore structures.<sup>16</sup> Specific to Arctic challenges, and responding to an infrastructural need for extraction, these make up the new Arctic city as it becomes one point within a global network.

Various predictions on the event of peak oil suggest the point at which the rate of global oil production will begin to decline. However, while this date remains uncertain what *is highly* certain is that Arctic reserves will eventually dry up after 20-35 years of production. It is this very volatile nature of gas urbanism, its imminent and looming demise that poses significant threat to the lifespan of the urban settlements it once helped to create. The notion of the urban corpse points to the lifeless remains of a city following the rapid decline of a temporal industry and the resultant retreat of the economy it supported. Dubai exemplifies the risks of such short-sighted, economy-driven urban expansions. Now reaching the phases of the post-oil corpse, Dubai once rose to its urban prominence through marketing the new urban morphologies of a global desert city built on the economic luxuries of a quickly depleting oil reserve.

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<sup>13</sup> Sassen, Saskia. *The Global City: New York, London, Tokyo* New Jersey: Princeton Architectural Press. 2001: 3-4.

<sup>14</sup> Bloch, Robin. *The Metropolis Inverted: The Rise and Shift to the Periphery and the Remaking of the Contemporary City*. unpublished doctoral dissertation, Urban planning, UCLA, 1994. (in Soja, 231): 225.

<sup>15</sup> Ruchala, Frank. “Oil: Crude City.” *The Infrastructural City: Networked Ecologies in Los Angeles*. New York: Actar, 2009: 54.

<sup>16</sup> Mason White (in Resource Fields: Gas Urbanism & Slick Cities) describes “gas urbanism” to refer to the infrastructural, architectural and engineering feats that dominate landscapes that are subjected to the development of significant gas fields across the globe. This term is used in several incidences throughout this thesis.





OFFSHORE URBANISM ?  
2050 FLEET ?



A dichotomy exists between such structures of permanence and the temporal lifespan of the extraction process, calling to action the resolving abilities of infrastructural innovation. Rather than subjugate a site to the impacts of the hydrocarbon economy, design is put to the test mitigating the incidence of the urban corpse. Acknowledging the phases of temporal decommissioning of the rigs, the movement of infrastructures, economies, and the temporal shifts of the city, the phased transition of these complex infrastructures could support new opportunities at urban revitalization. In this way, its vitality and prosperity is allowed to thrive following an imminent change of life where the remaining population is left with an infrastructure on which it can be sustained. Design should address the long-term use of offshore oil and gas structures and provide a synthesis rather than a gap between the presence and operation of the gas economy and the condition of the city upon the retreat of its economic attractiveness.

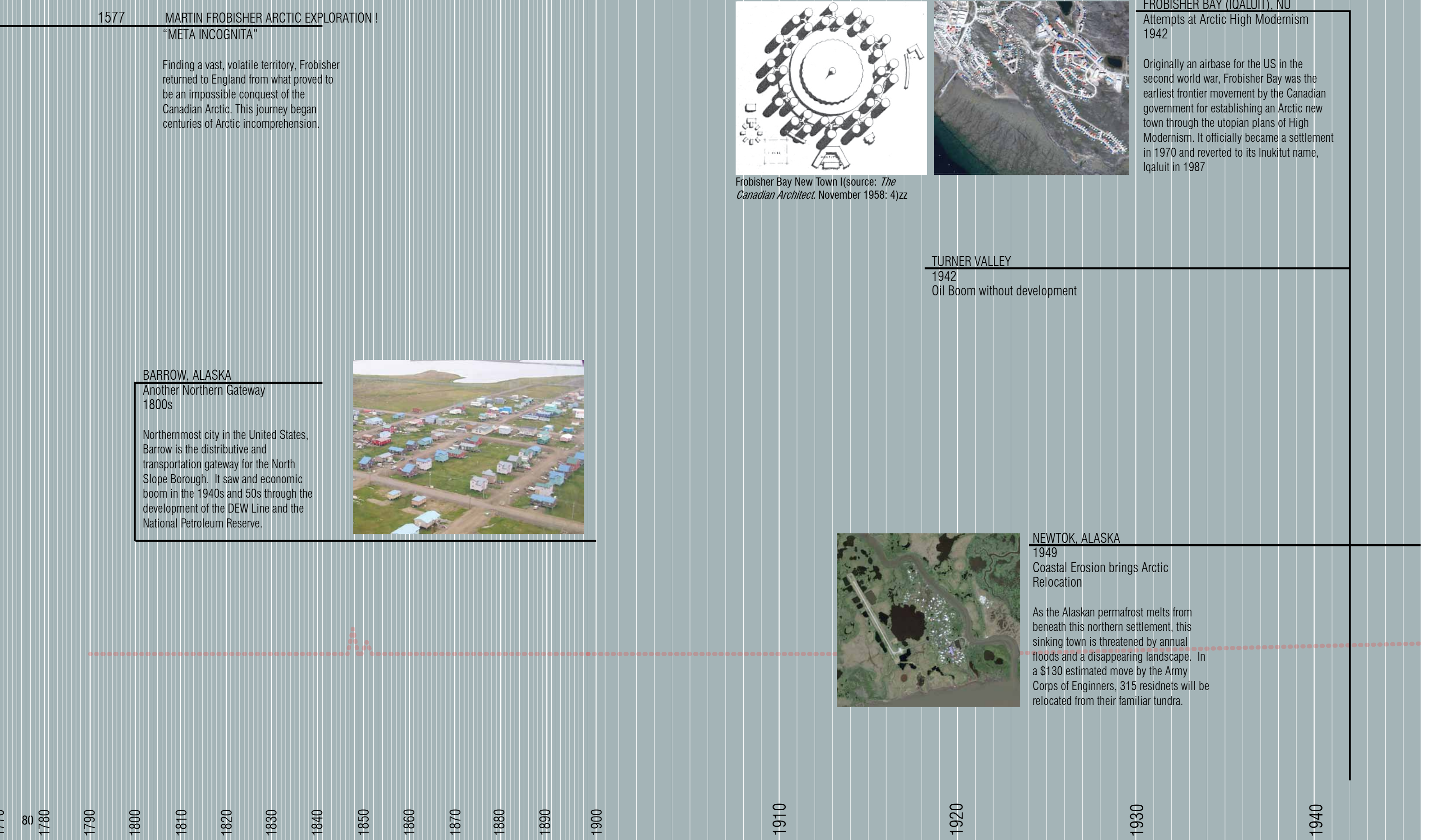
Operating amongst the infrastructural prowess imminent to the industry, this thesis aims to resolve the incompatibilities of economy, environment, and infrastructure that lead to the urban corpse. Oil and gas operations require huge capital investment, especially as increasingly deep-water and technologically-intensive practices and terrains are explored. The reality that these very structures soon lay abandoned, finding no future use or opportunity for re-occupation, presents both an economic flaw and an architectural one. Design innovation can be used to embed both flexibility *and* permanence within the infrastructures of Arctic urbanism, so that in their longevity, they facilitate a transition of occupation and programmatic use. By finding programmatic and formal syntheses between the needs of the oil industry and the future urban occupation of the community, there is great potential to maximize the entire lifespan of the massive infrastructures of gas urbanism.



# ARCTIC URBANISM

What does it mean to urbanize the far North?

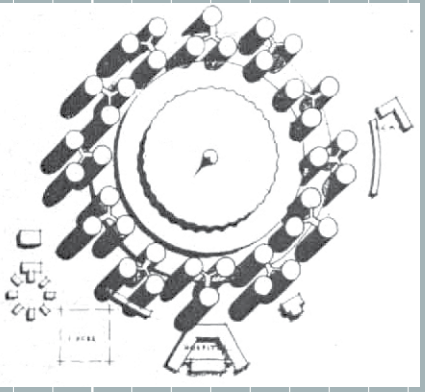
Precedents and Discourse



1577

### MARTIN FROBISHER ARCTIC EXPLORATION ! "META INCOGNITA"

Finding a vast, volatile territory, Frobisher returned to England from what proved to be an impossible conquest of the Canadian Arctic. This journey began centuries of Arctic incomprehension.



Frobisher Bay New Town I (source: *The Canadian Architect*, November 1958: 4)zz



### FROBISHER BAY (IQALUIT), NU Attempts at Arctic High Modernism 1942

Originally an airbase for the US in the second world war, Frobisher Bay was the earliest frontier movement by the Canadian government for establishing an Arctic new town through the utopian plans of High Modernism. It officially became a settlement in 1970 and reverted to its Inuktitut name, Iqaluit in 1987.

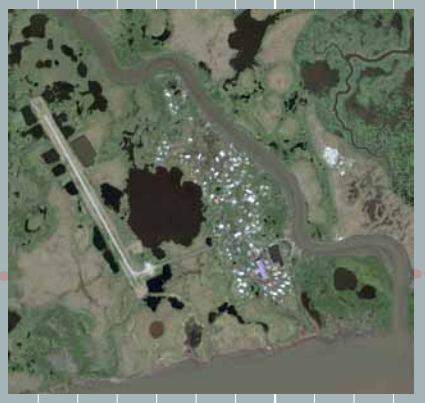
### BARROW, ALASKA Another Northern Gateway 1800s

Northernmost city in the United States, Barrow is the distributive and transportation gateway for the North Slope Borough. It saw an economic boom in the 1940s and 50s through the development of the DEW Line and the National Petroleum Reserve.



### TURNER VALLEY

1942  
Oil Boom without development



### NEWTOK, ALASKA 1949 Coastal Erosion brings Arctic Relocation

As the Alaskan permafrost melts from beneath this northern settlement, this sinking town is threatened by annual floods and a disappearing landscape. In a \$130 estimated move by the Army Corps of Engineers, 315 residents will be relocated from their familiar tundra.

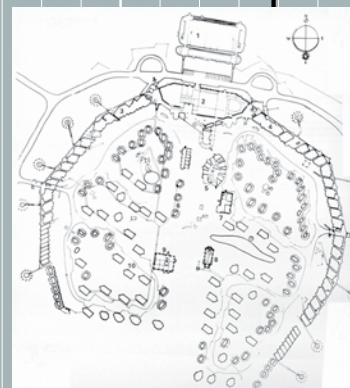
## COLVILLE ISLAND, AK

DISTANT EARLY  
WARNING (DEW) LINE  
1954-57 (construction)

## RESOLUTE BAY, BAFFIN ISLAND,

NUNAVUT  
1947  
High Arctic Relocation Program

Residents of northern Quebec were forced into this government planned high Arctic community. With an airfield and weather station in operation, Resolute grew at staging point for Polaris Mine to the northwest.

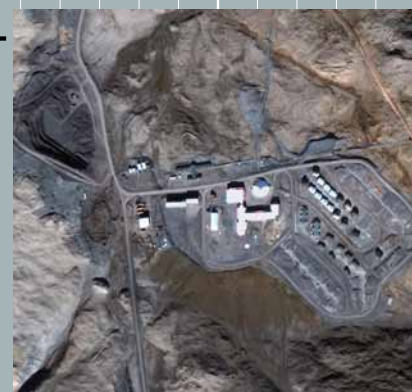


(Collymore, Peter. *The Architecture of Ralph Erskine*. New York: St. Martin's Press. 1994: 34. )

## NANISIVIK MINE, BAFFIN ISL., NU

1976-2002  
Canada's First High Arctic Mine

A community-based operation, the construction of the town site occurred jointly between the Government of the Northwest Territories and Nanisivik Mines Ltd. and housed Inuit and southern workers.

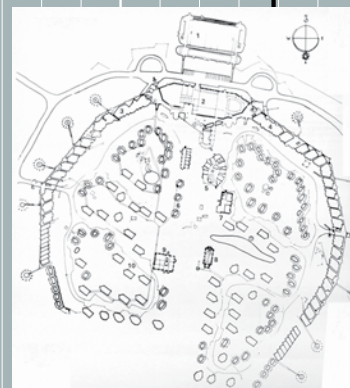


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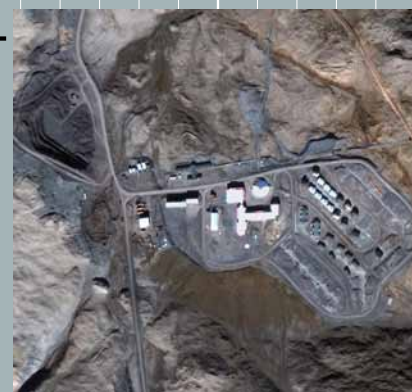


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## POLARIS MINE, NUNAVUT (NU)

1982-2002

A fly-in/fly-out community, Polaris was set up after significant research and attempts to establish a relationship between resource extraction and the surrounding Inuit communities.



## INUVIK, NORTHWEST TERRITORIES

1953  
Overflow Urbanism

Originally settled to house the ever-expanding population of Aklavik, Inuvik quickly developed as an Arctic boomtown through petroleum and resource operations within the Mackenzie Valley.



(Inuvik, 1961. From Ray White et al, *Inuvik*. ([http://jproc.ca/rrp/inuvik1961\\_b.jpg](http://jproc.ca/rrp/inuvik1961_b.jpg))).

ROADS TO RESOURCES 1957 John Diefenbaker, PM.

This federal campaign pushed development into Northern Canada in support of petroleum and other resource explorations.

HIGH MODERNISM HITS THE ARCTIC !

Government forces indigenous people into permanent settlements in the far NORTH

Cold War Crisis creates threat of Soviet attack

A period of heightened threat of Soviet attack pushed US and Canadian incentive to occupy and claim the vast Northern Arctic as a protective region for the heartland of North America.

DEMPSTER HWY is the first overland crossing of the Arctic Circle

## DIAMOND MINE, NT

2003

Model for Local Employment

With 38% aboriginal employment rate in 2004, this diamond mine sets an example for the socio-economic benefits of employment and education of local indigenous populations on account of resource extraction and Arctic urbanism. By 2010, nearly \$2 billion has filtered back into local business. Huge water retention dikes were constructed to safeguard mining facilities and accommodations.



2013

1950

1960

1970

1980

1990

2000

2010

2020

2030

2040

2050



## Arctic Urbanism Discourse and History:

Central to discussions on redesigning Arctic Urbanism is an understanding of the discourse and historical precedents that have addressed the question of what it means to urbanize the Far North. First, to ask what is meant by “urban”, becomes a critical starting point in the context of the dispersed landmass of the North. Northern Canada houses one of the world’s lowest population densities, which finds itself at 0.02 people per square kilometer in the Northwest Territories. In the hamlet of Tuktoyaktuk, where the population is under 1000, there is a notable increase in “vast human features in comparison to areas surrounding it”.<sup>17</sup> While this construction of urbanity might not be equal across the globe, to “urbanize” a rural settlement such as Tuk, suggests that some global change or pattern acting on the area will cause it to take on more urban characteristics so as to suggest a movement away from the rural or traditional condition. Northern settlements such as Tuk might never reach a booming population count or dissolve their rural status to be recognized globally as a “city”. However, urbanization in this Northern context recognizes a drastic, marked, and sudden change from traditional or rural conditions to a more dense, globally connected, modernized condition made possible by the development of the area’s architectural and infrastructural landscapes. As a term relative to the vast territory of the North, urbanization of the Arctic suggests a period of rapid development with the intention of densifying, modernizing, and establishing a more connected northern frontier.

While the Canadian Arctic remains a relatively unpopulated territory, the rise in attempts to conquer this landmass throughout history helps to exemplify what is understood in Canada as a quest to urbanize the North. While the indigenous population has occupied the land for thousands of years, European exploration began four centuries ago. As a first wave of foreign exploration, Martin Frobisher’s 1577 expedition brought exploration to the unknown bounds of the Canadian Arctic. Unsuccessful at conquering this harsh context, Frobisher’s travels were characteristic of nearly four centuries of attempts to understand and survive this “meta incognita”, what Queen Elizabeth deemed as a land “beyond the unknown things”.<sup>18</sup> While its scale, climate and a near-invisible population set the stage for its incomprehensibility, it also and kept the Canadian Arctic free from European conquest. Despite these external failures, however, thoughts of northern conquest as an act of national sovereignty began to brew from within the heart of the Canadian mainland. After decades of neglecting its Arctic landmass and population, the Canadian government, in the middle of the twentieth century, began to

<sup>17</sup> Urban Area. (n.d.) Retrieved from “Urban Area” in Wikipedia: [http://en.wikipedia.org/wiki/Urban\\_area](http://en.wikipedia.org/wiki/Urban_area)

<sup>18</sup> Waldron, Andrew. *Frobisher Bay Future: Megastructure in a Meta-Land*. Architecture and Ideas. Retrieved from [http://architectureandideas.com/issues\\_PDF/Ai\\_issue08/Ai\\_v8\\_Waldron.pdf](http://architectureandideas.com/issues_PDF/Ai_issue08/Ai_v8_Waldron.pdf) : 21.

take notice of the North’s attractiveness. They saw an area that appealed to the global interest in geopolitical expansion, which already had other nations pushing development into frontier areas. This expansion was afforded by wartime infrastructures already in place and a national imperative to push development to new territorial limits. As “Canada’s last frontier” it was highlighted as a geographic and resource hotspot, quickly being labeled as an area worthy of both defending and populating. Geographically, following the onset of the Cold War, a growing concern for the open airways and expansive bounds that separate North America from its Soviet enemies drove an era of territorial expansion in the name of US and Canadian defense. Under the Diefenbaker administration, this development manifest most notably through the construction of the Distant Early Warning (DEW) Line across the 69th parallel. The DEW line demonstrated that the necessary response to such unknown and looming threat was to establish a stronghold of permanent settlement across this barren landscape in any way that the government saw fit. Matthew Farish describes this time as

a dual geopolitical and scientific frontier...when fear of a Soviet assault led to an alternate invasion of Arctic landscapes by research teams, administrators and troops; all pushing northwards to occupy and materialize the region.”<sup>19</sup>

Prime Minister John Diefenbaker’s “Northern vision” helped to accelerate Arctic development, setting into motion the nation’s support for claiming and uncovering the riches of the North, which remained largely untouched at that time. His “Road to Resources” program in 1957 drove an era of national support for rapid northern infrastructural development so as to to explore, exploit and understand this “new world to conquer”.<sup>20</sup> This obsession brought on a wave of northern scientific research, mapping, and extensive support for military development. As well, significant funding for oil and gas exploration brought jobs, wage-based economies, and other southern luxuries up North. However, attempting to access northern resources in this exploitative manner, Diefenbaker’s incentive was characteristic of the nation’s new and overbearing fascination with the hostile environment of which they still new very little about. His “great historic mission” was characteristic of government policy at the time and in the following decades. These policies demonstrate a dedication to southern goals and lifestyles in their ability to inform “the building of a nation in the northern half of this continent truly patterned on *our* way of life.”<sup>21</sup> In Canada’s history, attempts at urbanizing its Arctic territory has been approached as a national quest to exert its southern might.

Following this quest for Northern expansion, the Canadian government pursued the notion of the Arctic town through several failed, insensitive, and unrealistic urban

strategies that victimized the Inuit traditional way of life. While the Cold War marked a period of increased northern development and concern, this manifest itself a short-sighted national vision that disregarded the lives of those already inhabiting the land. This frontier momentum exerted government control over the northern territories through the establishment of permanent settlements from which the government could organize military-led construction to rapidly construct the new frontier. Unable to populate these harsh settlements themselves, several forced relocation programs ensued that forced the Inuit to permanently occupy these new cities. This “nationalist nordicity” was seen as a means of bolstering Canada’s sovereignty over the land and concern themselves with the populations living there at a time when risk of attack from neighboring countries was heightened.<sup>22</sup> Moreso, the notion of the permanent settlement itself condemned the nomadic lifestyle known to these populations and forced them to adapt a new way of living. Forced settlements and the 1944 Family Allowance Act brought about a new permanent lifestyle without ensuring the proper transition and success of a wage economy for its Northern people. What was missing was the government’s establishment of a framework in which the indigenous people could adapt. This adaptation was further hindered as 1958 marked the start of a series of commissions for high modernist design proposals to re-visualize a nation that stretched from coast to coast to northern coast. Lacking contextual research and an intuition of place that comes only with experience, these schemes were never concerned with the Inuit themselves, but were a way of materializing the success of the nation through conquering its northern land and adjusting the traditions of those living there. Through this modern vision of the Northern town, architecture became a means of exerting “a sweeping, rational engineering of all aspects of social life in order to improve the human condition.”<sup>23</sup> In this way, the megastructure became the means of constructing and repairing what they saw as wrong with Canada’s Arctic. They intended to fix this northern frontier in a form of “nation-building and sovereignty in post-war Canadian society”.<sup>24</sup> Seen through exertions of national sovereignty in the Arctic, the traditional way of life of the Inuit has a history of falling victim to the federal government’s execution of a short-sighted Northern vision.

<sup>19</sup> Farish, Matthew. “Frontier Engineering: from the Globe to the Body in the Cold War Arctic.” *The Canadian Geographer*. Vol50, No2. 2006::179.

<sup>20</sup> Coates, Kenneth. *Canada’s Colonies: A History of the Yukon and the Northwest Territories*. Toronto: James Lorimer and Company. 1992: 199.

<sup>21</sup> Stoneman-McNichol. *On Blue Ice: The Inuvik Adventure*. Yellowknife: Outcrop. 1983:43.

<sup>22</sup> Farish, Matthew and P.W. Lackenbauer. “High Modernism in the Arctic: Planning Frobisher Bay and Inuvik.” *Journal of Historical Geography*. Vol35, no3. 2009:526.

<sup>23</sup> Scott, James. *Seeing like a state: how certain schemes to improve the ahuman condition have failed*. New Haven: Yale University Press, 1998: 88.

<sup>24</sup> Waldron, Andrew. *Frobisher Bay Future: Megastructure in a Meta-Land*. Architecture and Ideas. Retrieved from [http://architectureandideas.com/issues\\_PDF/Ai\\_issue08/Ai\\_v8\\_Waldron.pdf](http://architectureandideas.com/issues_PDF/Ai_issue08/Ai_v8_Waldron.pdf) : 21.

Arctic Megastructure :  
the Case of Frobisher Bay

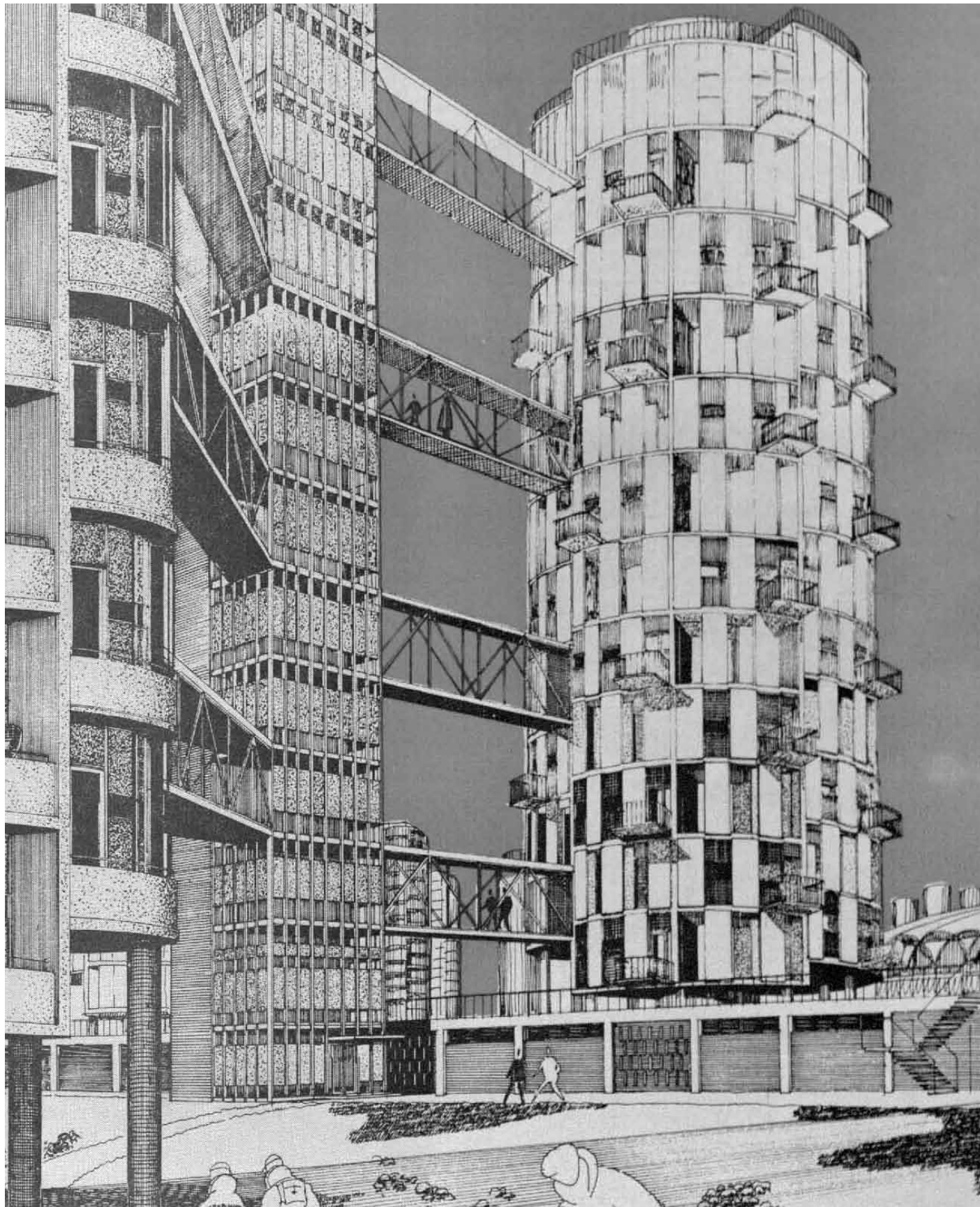


Figure 1: Frobisher Bay New Town I. An Arctic Utopia. (source: *The Canadian Architect*. November 1958: cover illustration.)

The problems of high Arctic, high modernist schemes and their utopic visions of northern living are exemplified in Frobisher Bay, the proposal for an Arctic new town in Nunavut. As the earliest frontier settlement by the Canadian government, Frobisher Bay New Town's urban fabric was initially set up as a functional landscape from which the federal government could strategize Northern development. Established as a military outpost for the second World War, and transitioning to a radar station and headquarters for the construction of the DEW Line, Frobisher's building stock reflected the needs of rapid deployment and ease of diassembly. Through the Eskimo Housing Loan Program, prefabricated "matchbox" houses were delivered to communities like Frobisher Bay, which demonstrated a typical characteristic of government-led northern construction in their detached relationship between building and environment. As its economy and stature as a federal administration town grew, so too did the national necessity to establish a new and advanced urban form for this and other Arctic settlements. Thus, the Arctic megastructure was born. Utopic in vision, this federal idea of Arctic urbanism showed a drastic tendency to disconnect the construction of an Arctic architecture from the history and memory of indigenous living, in what Waldron notes as a romantic relationship between the Canadian imagination and the vast Arctic landscape.<sup>25</sup> The architectural byproducts of this romantic, national nordicity manifest themselves in two government-led schemes to provide immediate and drastic remediation of the conditions of Inuit living at Frobisher Bay. In 1958, the scheme for New Town I expressed an obsession with space age that likened Canada's knowledge of the Arctic to the vague and unrealistic visions of what it might be like to inhabit a community on Mars. (See figure 1.) While the second scheme in 1960 showed no such conceptual imagery, it did present a megaproject of a grand northern endeavor. As with the matchbox houses, "the architects of the Frobisher Bay New Town introduced a different relationship between environment and dwelling; a relationship that imagined an Arctic architecture in a self-contained system that rejected indigenous living and created a modern oasis within the Arctic desert."<sup>26</sup> As the brief period of federal confidence in conquering the North fell, so too did plans for redesigning the Arctic Urban centre through Frobisher Bay. The new town itself demonstrates the failure of the arctic megastructure as a mechanism for nation-building and territorial and cultural change. Favoring scientific, technological and formal prowess over anything learned from the land, the utopian dreams of constructing a new Northern architectural identity of this type have continuously diminished under

<sup>25</sup> Waldron, Andrew. *Frobisher Bay Future: Megastructure in a Meta-Land*. Architecture and Ideas. Retrieved from [http://architectureandideas.com/issues\\_PDF/Ai\\_issue08/Ai\\_v8\\_Waldron.pdf](http://architectureandideas.com/issues_PDF/Ai_issue08/Ai_v8_Waldron.pdf) : 30.

<sup>26</sup> *ibid.*:30.

the volatility of harsh Arctic winters, unstable economies, and geopolitical barriers to development. Frobisher Bay New Town demonstrates a failed attempt to rapidly settle the Arctic through urban schemes that mark a federal incentive to address Arctic living by denying and re-visioning the traditional and cultural way of life in the North.

Ralph Erskine:  
Arctic Architect

Learning from the failures of Arctic Modernism, the work of Ralph Erskine acknowledges the negative repercussions of Inuit relocation schemes to develop responsive urban and architectural designs that demonstrate a more dedicated concern for the particularities of place and the challenges they present to Arctic living. Acknowledging the complexity and severity of the Arctic context, Erskine's work in the Arctic evolved with a body of research and writing which he established to outline the criteria for northern construction. By establishing such criteria as creating a protective barrier between indoor and outdoor climates and allowing the form of the building to catch the incidence of sunlight, Erskine established a baseline condition in which his work came to life. Developing 'A grammar for high latitudes', which he presented to Team 10, Erskine's research into climate, snow, ground conditions, light, air movement, sun, fauna, vegetation and micro-climate (each diagrammed and notated), showed a level of Arctic concern not found in the bulldozing government schemes at Frobisher Bay. However, still flexing his formalist muscle, Erskine allowed these functionalist qualities to create a utilitarian, picturesque aesthetic as he set out to re-visualize the Arctic community. His design for Resolute Bay, in the then Northwest Territories, exhibited community characteristics of scale, clustered living and density that helped to formalize the act of living in such an extreme context and society.(See figure 2) Nested in an irregular landscape, his irregular design of a perimeter sheltering structure nests the community within one of these "livable winter cities". Erskine utilized the context to push innovation of form, technology, and what we might today call living "sustainably" in the North. Despite these sensitivities and formal justifications, his Arctic cities in many ways recall the utopian vulgarity of the government's schemes for Frobisher Bay. As with Frobisher, Erskine's designs diminished with the rapid demise of the political and economic opportunism that briefly dusted the Canadian North with plans for such high modernist urban schemes. In Erskine's case, the success of the system relied on the existence of each part of the design working together. Thus, the construction of a single wing of his sheltering perimeter structure was an incomplete and ineffective execution of his research. In this way, "[h]is single Resolute structure stands as forlorn relic of modernity's hubris and its disruption of the idealistic and humane intent of Modernism's theoretical project."<sup>27</sup> Erskine's urbane and contextual scheme for a socially inclusive and technically advanced arctic community mobilized the utopic sublimity within the Modern Movement and the placeless spatiality embodies in modernist design ideology."<sup>28</sup> The work of Ralph Erskine demonstrates that despite



Figure 2: Ralph Erskine's utopic sketch for Resolute Bay. (source: Egelius, Mats. *Ralph Erskine, architect*. Stockholm: Byggfrlaget, 1990: 81.)

<sup>27</sup> Liscombe Rhodri Windsor. "Modernist Ultimate Thule." *Canadian Art Review* Vol31, Is 1-2. 2006: 78.  
<sup>28</sup> Ibid.:78.



seeking sensitivity to and innovation from extremes of context, the utopian dreams of constructing a new Arctic urban and architectural identity have continually fallen to the volatility of unstable economies, and geopolitical barriers that prevented development and a rapid deployment of urban form during a fleeting period of national concern.

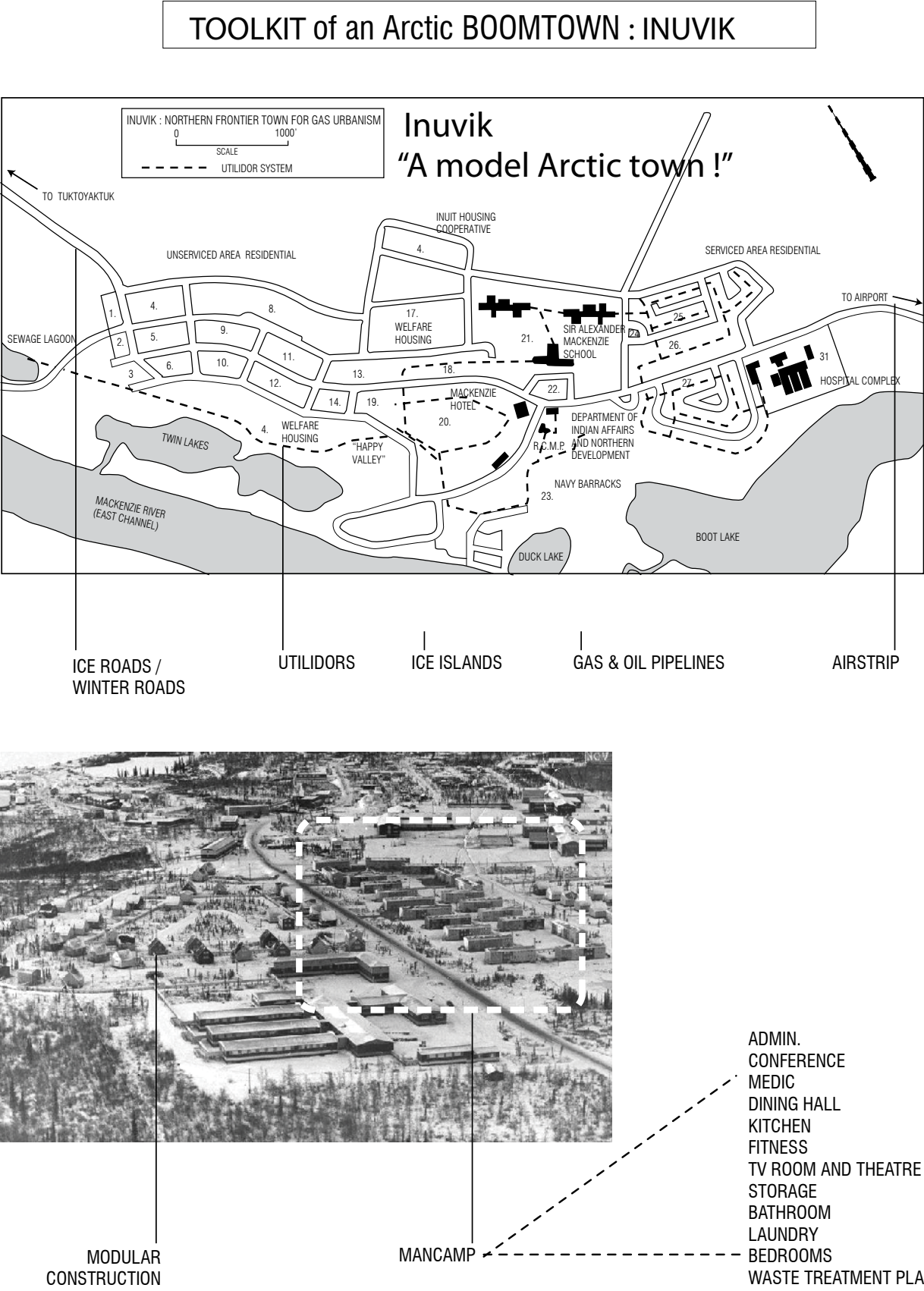


Figure 3: Inuvik, 1961. From Ray White et al, Inuvik. ([http://jproc.ca/rrp/inuvik1961\\_b.jpg](http://jproc.ca/rrp/inuvik1961_b.jpg))



Gas Urbanism’s Boom  
to Bust : The Case of  
Inuvik

The story of Inuvik’s development on the Mackenzie Delta, exemplifies the immense implications that oil and gas exploration can have on the rise of small or previously non-existent Arctic settlements. Originally settled to house residents pushed out of the ever-expanding community of Aklavik, Inuvik quickly grew as a petroleum boomtown at the rapid pace of the Mackenzie Valley operations. The oil boom began in the Northwest Territories in the 1920s with the first oil well drilled at Norman Wells, south of Inuvik. As well, Imperial Oil’s seismic exploration and the rapid takeover of Alaska’s Prudhoe Bay, began a preliminary period of oil expansion in the Canadian Arctic. With the establishment of the Task Force on Northern Oil Development and a highway finally connecting southern Canada to the Arctic, Inuvik became a prime geographic location to serve the oil industry at the banks of the Mackenzie River. As Imperial Oil moved its operations and administration into Inuvik, workers from the south quickly followed, enticed not by the location of this stark, unpopulated terrain, but by the abundance of jobs in the construction of the Imperial base camp. Support infrastructure such as airstrips, marine services and winter roads were constructed for their onshore town construction. In a fast transition from a resource-based economy to a wage-based economy, the Inuvialuit left their traditional skill set of working their land to comprise a large portion of the camp workforce in Inuvik. They worked as rig operators, cooks, camp attendants, roughnecks (unskilled or semiskilled rig laborers), derrick hands, bear monitors, expeditors and truck drivers in a community established outside of productive hunting, fishing and trapping networks upon which these people typically survived. While fueling their booming economy, this gas urbanism created strife between Inuvialuit and southern transients, and turned high-school dropouts out of many northern youth who were lured by the attractive, albeit temporary, salaries. Moreso, noting the challenges of Arctic Urbanism previously discussed in this paper, Alexander Ervin studies that in Inuvik “there is a certain resentment among the local people over the fact that they were not consulted to any great degree in the selection of the site.”<sup>29</sup> However, characteristic of such boom and bust economies, exploration halted with the 1977 Berger Commission and the decision to cease oil production in Canada’s North for at least 10 years. The Commission’s intent was to allow the Inuvialuit to establish themselves and their development ambitions within their traditional territory prior to exploitation from the oil and gas industries. As the first companies of Inuvik quickly pulled out in 1979, the economy that was so quickly inflated by the business of oil rapidly burst and lost its foundations. Many lessons on Arctic Urbanism under the veil of oil and gas exploration demonstrate the need to consider the post-oil economy upon which the remaining community can thrive.

The Distant Early  
Warning Line

During the Cold War era, architectural installations under the Distant Early Warning (DEW) Line radar controls were strung across the 69th parallel from Alaska to Greenland, touching down in the Canadian Arctic every 80 kilometers. While the construction of the DEW Line stations demonstrate the complexity of US control and influence over Canadian lands, the stations have become significant markers of Canadian sovereignty and innovative Arctic urbanism through their architectural invention. As the DEW Line was set up to secure constant monitoring against Russian attack, the stations also strengthened Canada’s presence in the Arctic. Asserted under US defense funds, this roughly \$500 million project employed 25,000 people through the construction of sixty-six warning stations completed between 1954-57. The intention of the DEW line was to create a stronghold of radar stations spaced so that “any aircraft flying at any feasible altitude above the terrain would be in the unimpeded line of sight of at least one station.”<sup>30</sup> As technologies became obsolete and the threat of Soviet attack fell with the collapse of the Soviet Union in the mid-80s, the DEW Line changed to the North Warning System, and in some cases the stations were overtaken by the DEW Line Clean Up Protocol, part of Canada’s plan for dealing with hazardous sites across the country. These changes in function, however different from original intent of the stations, still allowed a national presence in the North as the lifespan of these innovative stations continuously stretched.

While securing Canada’s national sovereignty over the North, the DEW Line stations also served as important architectural figures through their fabrication and design in the Arctic context. Designed by Buckminster Fuller through his company Geodesics Inc., the domed radar stations instill the North with Fuller’s growing concerns for the ecological principles of geometry and energy consumption.<sup>31</sup> Geometrically, the stations’ most notable features were the geodesic Radomes that acted as closed vessels able to survive with little and infrequent maintenance. Stretching minimum materials over a maximum area to achieve maximum structural strength, the 361 self-bracing triangles, combining the sphere and the tetrahedron, could withstand winds of up to 210 mph - an Arctic conquest. Rapidly deployable by skilled labour, lightweight and transportable by flatpack shipments, these fibreglass and plastic Radomes accommodated the logistical complexities of their remote Arctic locations. An investment in Arctic building systems

<sup>29</sup> Ervin, Alexander M. “Conflicting styles of life in a northern Canadian town.” *Arctic* Vol22. 1969: 97.

<sup>30</sup> Ray, Thomas W. *A History of the DEW Line, 1946-64*. Maxwell AFB, AL: Air Force Historical Research Agency, Air Defense Command Historical Study 31. n.d.

<sup>31</sup> Anker, Peder : *From Bauhaus to Ecohouse: A History of Ecological Design*. Baton Rouge: Louisiana State University Press, 2010: 81



certainly revolutionized the time and established several DEW Line sites as significant heritage buildings across the Canadian Arctic. These “real plug-in megastructures” demonstrate a moment of Arctic development as it begins to define not only an act of sovereignty but an architectural frontier.<sup>32</sup> Though constructed as an air-defense strategy, Canada’s DEW Line radar stations demonstrate how acts of nation-building can result in site-specific architectural inventions.

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<sup>32</sup> Waldron, Andrew. “Canada’s Distant Early Warning Line.” *Docomomo* no. 38. March 2008: 58.



Figure 4: DEW Line site at Tuktoyaktuk, NT. Taken 2010. (Photograph by author.)



CONCLUSION:  
RESPONSIVE STRATEGIES  
FOR A NEW ARCTIC  
URBANISM

With these attempts at Arctic Urbanism and an increased architectural definition of the North, Canada has faced several opportunities to exemplify - both architecturally and urbanistically - what it means to develop and urbanize the Arctic. Seen in the examples of high arctic modernist strategies of Canada's past, there exists the recurring inability to financially play out and test these modernist concepts and precedents to their fullest demonstration of utopian ideals. In this way "the recurrence of utopian ambition in post-war reconstruction-era policy succumbed to extremes of northern arctic climate, economy, and geopolitics" which disallow us from observing their physical and operational occupations.<sup>33</sup> Anthony Roberts has optimistically commented on this continuous need for defining an Arctic Urbanism, stating that,

Canada has a greater opportunity than any other country to provide a distinctive national architecture. It will be an architecture based not on a superficial style or on a tradition, but a new and pure form which to be successful, is bound to be unique. Its originality will stem from design based on a social pattern and a series of physical and economic and political conditions which are not found collectively elsewhere in the world today.<sup>34</sup>

To do this properly, necessary contextual research into the many unknown challenges of Arctic living and building in a way that it moves to understand the place and the people as more than just "subjects of investigation and objects of reconstruction."<sup>35</sup> Moreso, an understanding of both the economic, ecological and cultural conditions particular to that place must be of primary concern. Lessons from the past, speak to exemplify both successes and failures of particular schemes, while as a collective, speaking to the need to strengthen and revisit the discourse on what it means to urbanize the Arctic.

<sup>33</sup> Liscombe Rhodri Windsor. "Modernist Ultimate Thule." *Canadian Art Review* Vol31, Is 1-2. 2006: 78.

<sup>34</sup> Roberts, Anthony. "Design for the North." *The Canadian Architect*. November 1958.

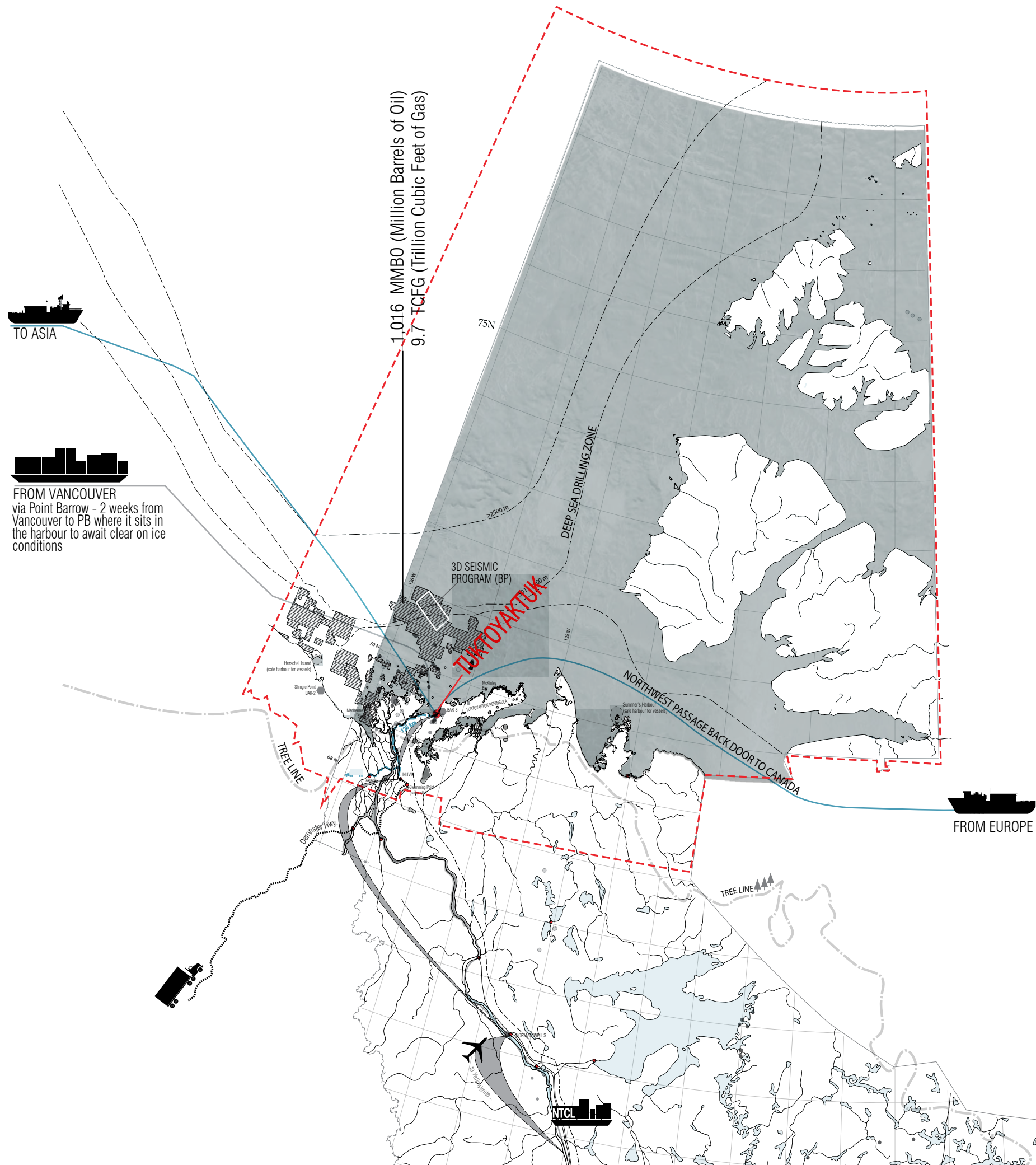
<sup>35</sup> Liscombe Rhodri Windsor. "Modernist Ultimate Thule." *Canadian Art Review* Vol31, Is 1-2. 2006: 71.





# TUKTOYAKTUK

Analysis of the Past, Present and Future

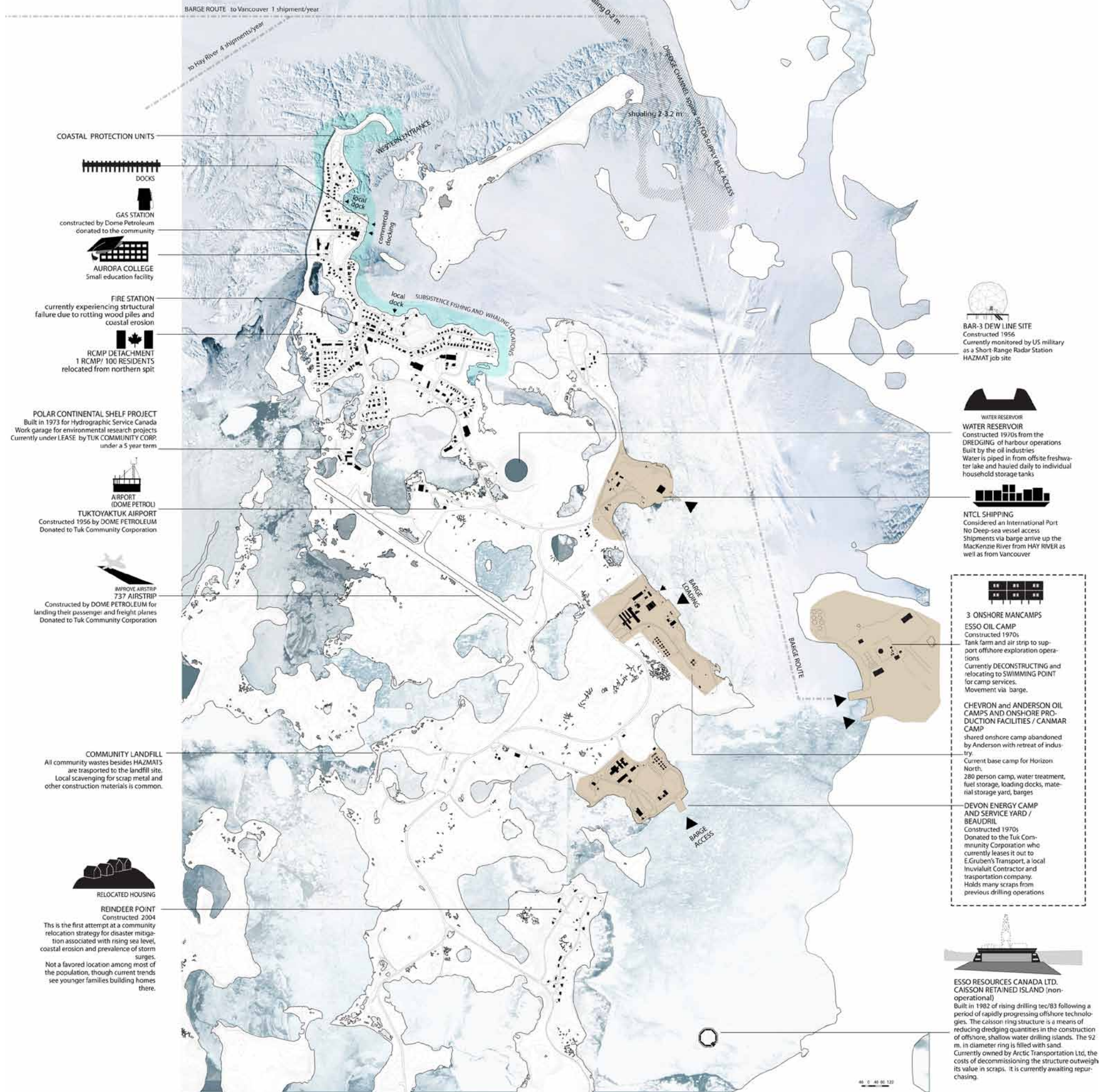


## THE RACE FOR OIL IN ICE



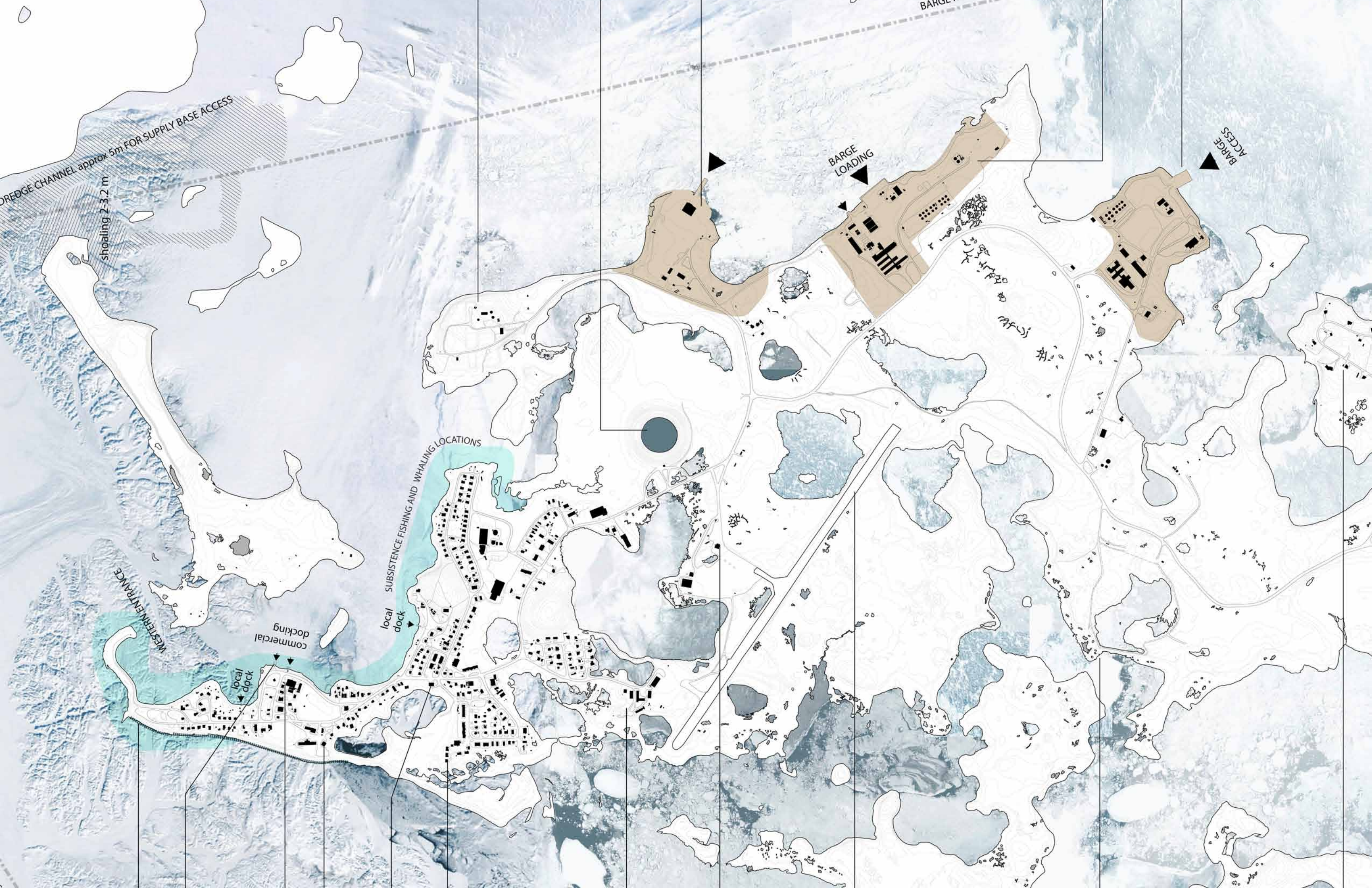


# ARCTIC ENTROPY : EXAMINING A COASTAL FRONTIER

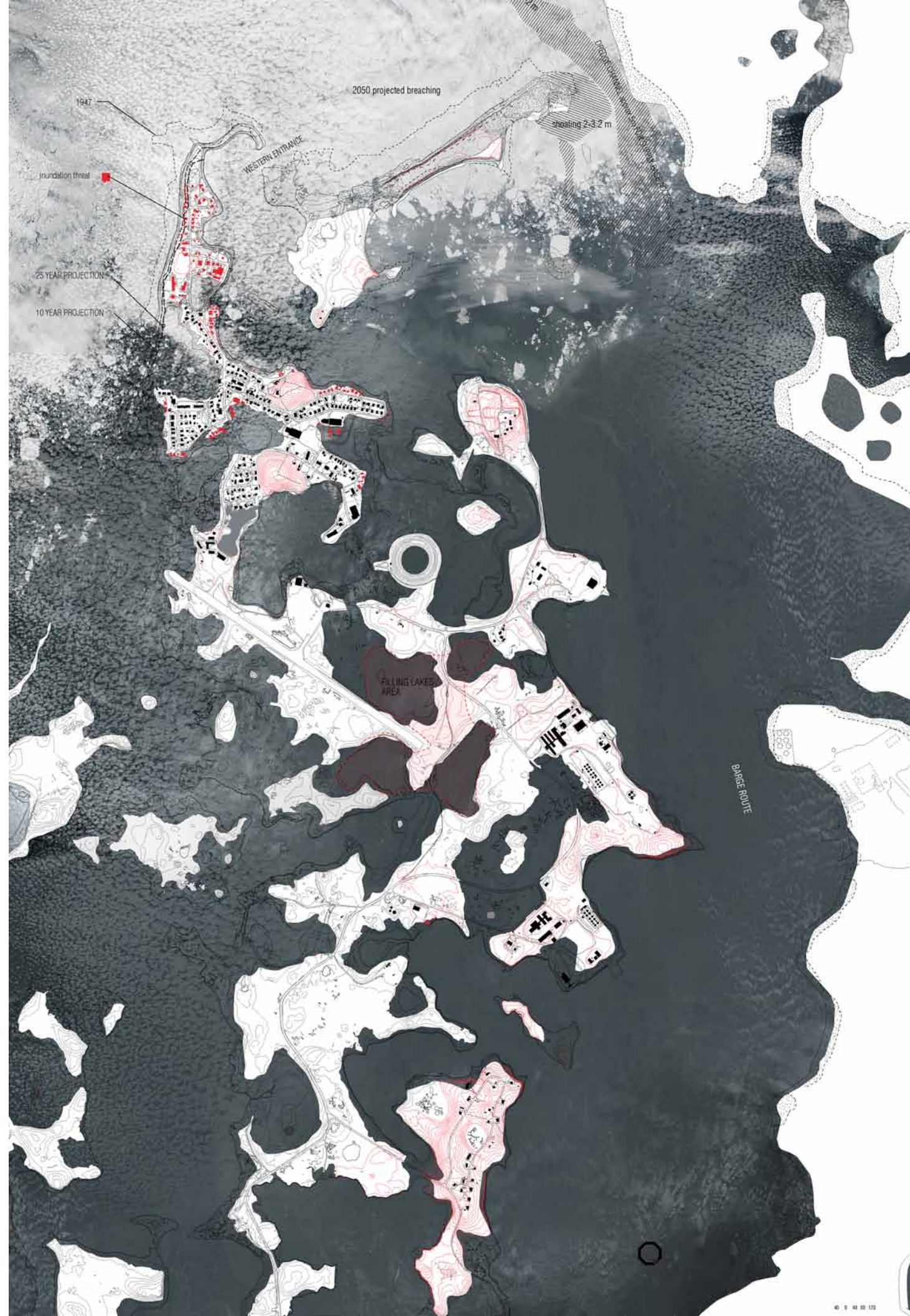


**2015 : CONDITIONS OF TUKTOYAKTUK AS LARGELY THE RESULT OF OIL AND GAS DEVELOPMENT IN THE 1970S-1980S**







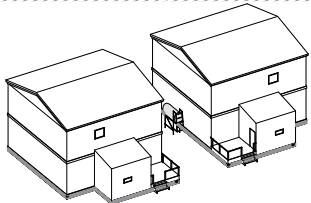


2050 : MAXIMUM SEA-LEVEL RISE  
WILL SEE TO THE INUNDATION OF THE  
MAJORITY OF TUK'S LANDSCAPE









**RESIDENTIAL**

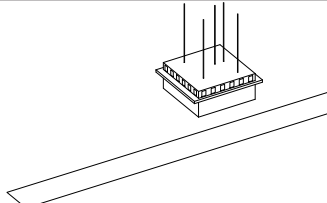
PROPERTY TERMS : RENT or OWN

USE : Private Residence, Group Housing, Tourist accomodations.

BUILDINGS : Single-family home , elderly housing, B & B, mobile home.

% OF TOTAL LAND AREA : 4%

% LAND AT RISK



**AIRPORT RESERVE**

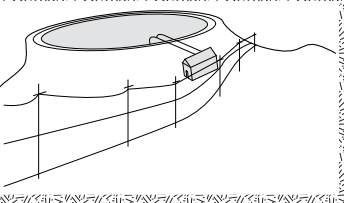
PROPERTY TERMS : GOV. NWT

USE : Local, Industrial and Government

BUILDINGS : 737 airstrip, Airport

% OF TOTAL LAND AREA : 16%

% LAND AT RISK



**ENVIRONMENTAL RESERVE**

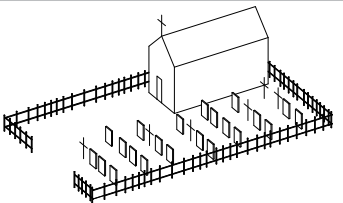
PROPERTY TERMS : TUK HAMLET

USE : Infrastructural Works, Civic Utilities, Access and Mobility

BUILDINGS : Water Reservoir and Facilities, Roads, Towers, Sewage Site, Navigation

% OF TOTAL LAND AREA : 30%

% LAND AT RISK



**PUBLIC SPACE**

PROPERTY TERMS : TUK HAMLET

USE : Civic functions

BUILDINGS : Gov. Offices, Church, Post Office, Schools.

% OF TOTAL LAND AREA : 1%

% LAND AT RISK



**COMMERCIAL**

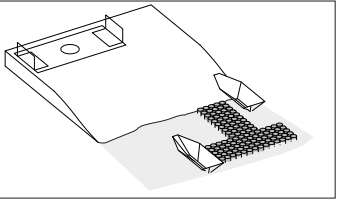
PROPERTY TERMS : LEASE, HAMLET

USE : Goods and Services

BUILDINGS : Multi and single-use Shops, Banks, Offices and Parking

% OF TOTAL LAND AREA : 1%

% LAND AT RISK



**OPEN SPACE**

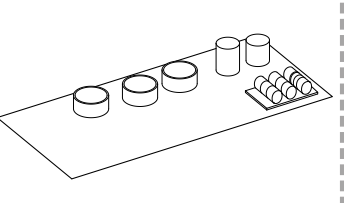
PROPERTY TERMS : TUK HAMLET

USE : Harbour access, Outdoor Recreation, Traditional and Cultural Activities

BUILDINGS : Docks, Sports and Camping, facilities, Smoke House, Sheds, Parks

% OF TOTAL LAND AREA : 35%

% LAND AT RISK



**INDUSTRIAL**

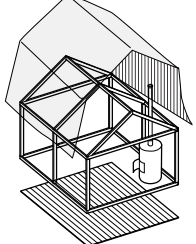
PROPERTY TERMS : OWN

USE : Warehousing, Storage yards, Harbour Access, Marine-based transshipment

BUILDINGS : Warehouses, Tank Farms, Dock infrastructure, Parking Garage.

% OF TOTAL LAND AREA : 13%

% LAND AT RISK

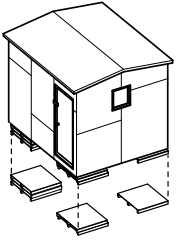


**TENT STRUCTURE**

OWNER : COASTAL HOMEOWNER

LANDUSE : OPEN SPACE / HARBOUR

RISKS :



**FISHING SHACK**

OWNER : LOCAL FISHERMAN

LANDUSE : OPEN SPACE / HARBOUR

RISKS :

**STRUCTURAL CONDITIONS**

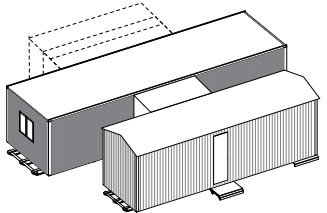
DEMOLISHED

GOOD

POOR

MEDIOCRE

**2015 : ZOOM-IN TO NORTHERN SPIT  
REVEALS RESIDENTIAL HOUSING  
CRISIS**

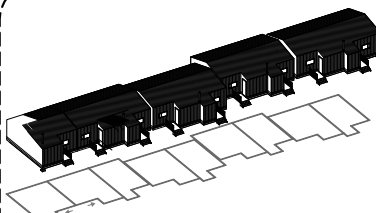


**SCRAP TRAILER ADAPTATIONS**

OWNER : SCAVENGER

OCCUPANTS : LOCAL RESIDENTS

RISKS :

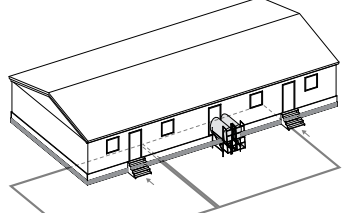


**ROW HOUSING**

OWNER : GOVERNMENT OF NWT

OCCUPANTS : LOCAL RESIDENTS

RISKS :

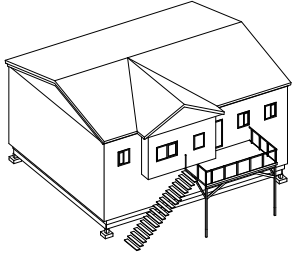


**DUPLEX PUBLIC HOUSING**

OWNER : GOVERNMENT NWT

OCCUPANTS : LOCAL RESIDENTS

RISKS :

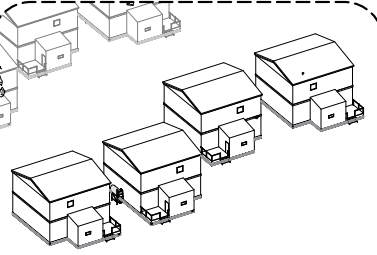


**PRIVATE HOUSING**

OWNER : LOCAL/FOREIGN RESIDENT

OCCUPANTS : LOCAL RESIDENTS

RISKS :

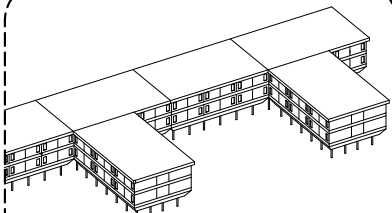


**COOKIE CUTTER PUBLIC HOUSING**

OWNER : GOVERNMENT NWT

OCCUPANTS : LOCAL RESIDENTS

RISKS :

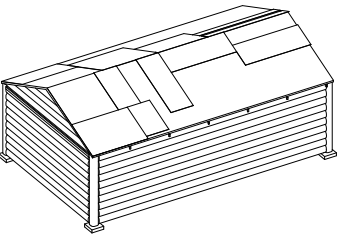


**MAN CAMP**

OWNER : OIL INDUSTRY

OCCUPANTS : FOREIGN WORKERS

RISKS :



**TRADITIONAL LOG HOUSE**

OWNER : LOCAL RESIDENT

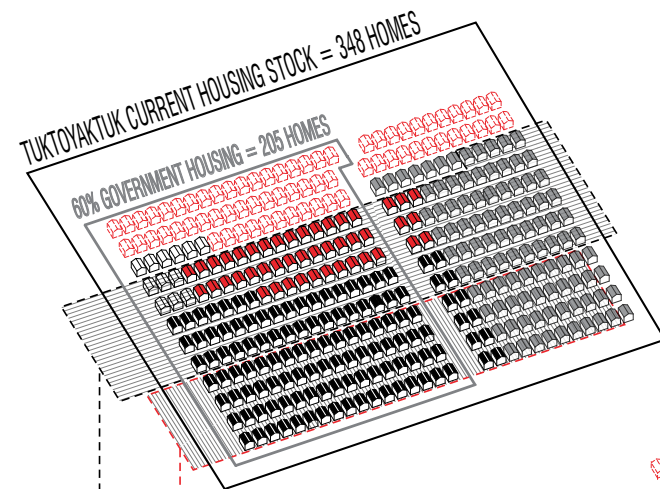
OCCUPANTS : LOCAL RESIDENTS

RISKS :



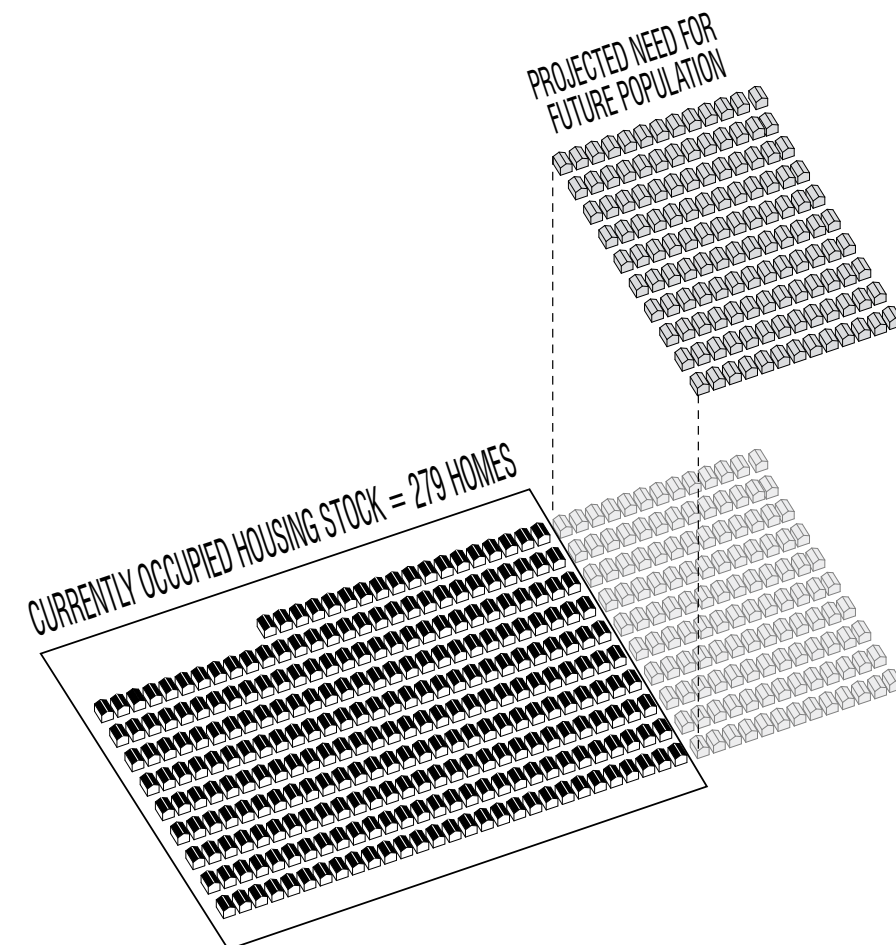






- 20% VACANCIES = 69 HOMES
- 13% OVER-CAPACITY = 45 HOMES
- 30% PRIVATELY OWNED = 104 HOMES
- 34% NEED MAJOR REPAIRS = 118 HOMES
- 32% ADEQUACY PROBLEMS = 111 HOMES
- 43% FAMILY IN CORE NEED = 150 HOMES

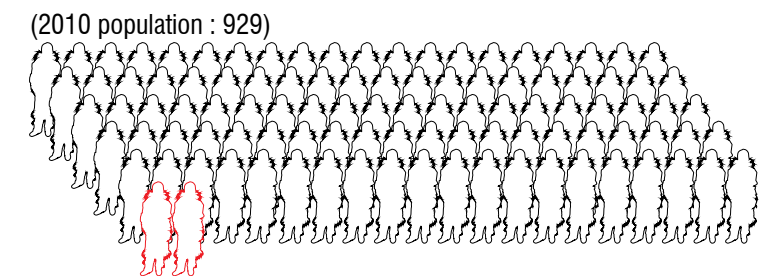
## DECLINING HOUSING STOCK



**34% HOMES LOST**

**150 HOMES NEEDED !**

**1000+**  
INCREASED TRANSIENT POPULATION



2% NATURAL POPULATION INCREASE

2050 : INUNDATION THREATENS  
WEAKENED HOUSING STOCK















2015 : MEAN SEA LEVEL



2025 : SEA LEVEL RISE



CONDITIONS OF SEA-LEVEL RISE  
PREDICTED TO OCCUR IN TUK

2050 : INUNDATION +2.5 m RISE





PHOTOGRAPHING TUK







LOG DEBRIS LIES STRANDED ON THE  
NORTHERN COASTLINE OF TUK INDICATING  
WATER ELEVATIONS AT TIMES OF SURGE  
REACHING UPWARD OF 2.4 METERS ABOVE SEA  
LEVEL.



























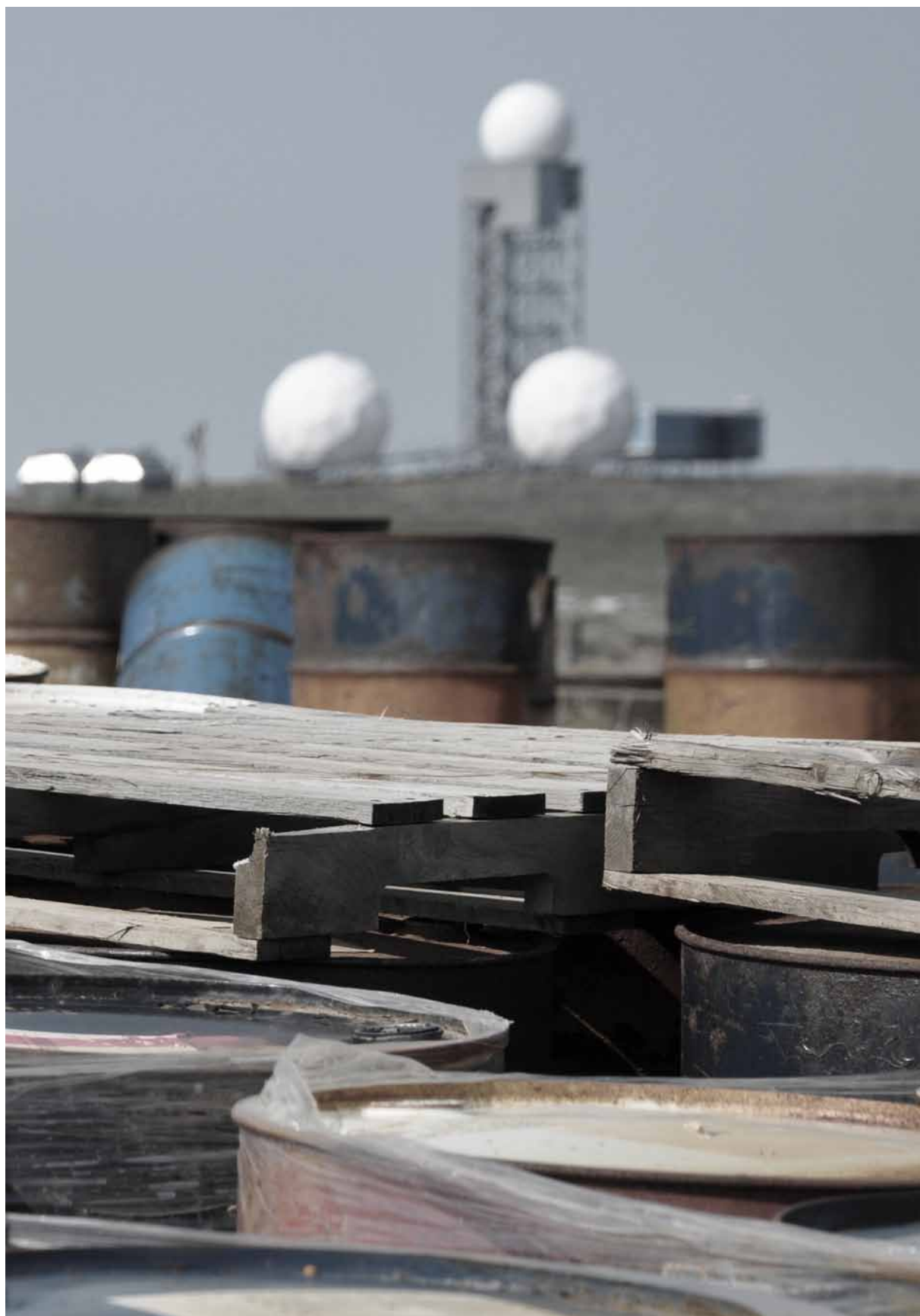














THE ERODING EDGE





THE DEFENDED EDGE





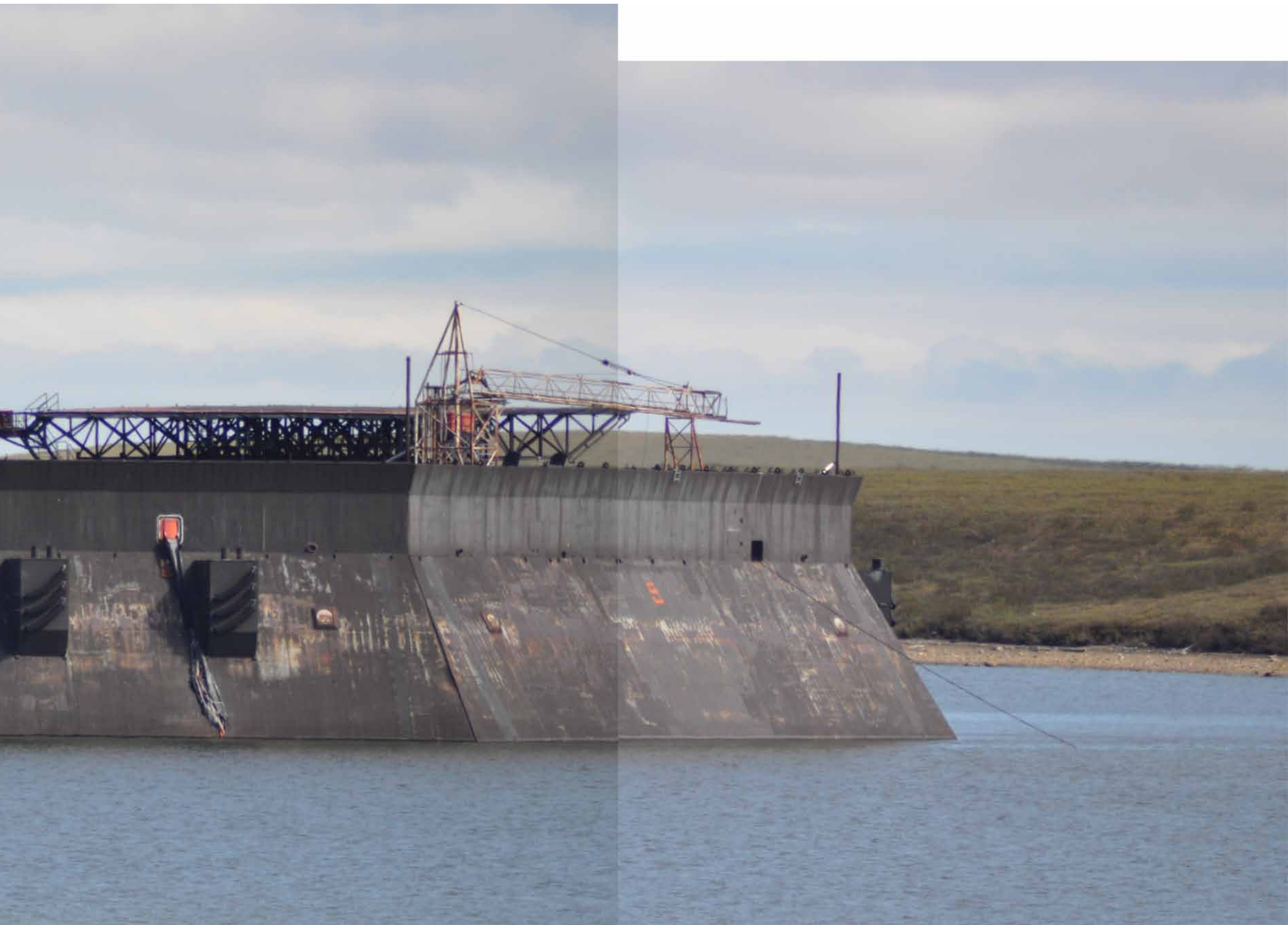




THE INDUSTRIAL EDGE









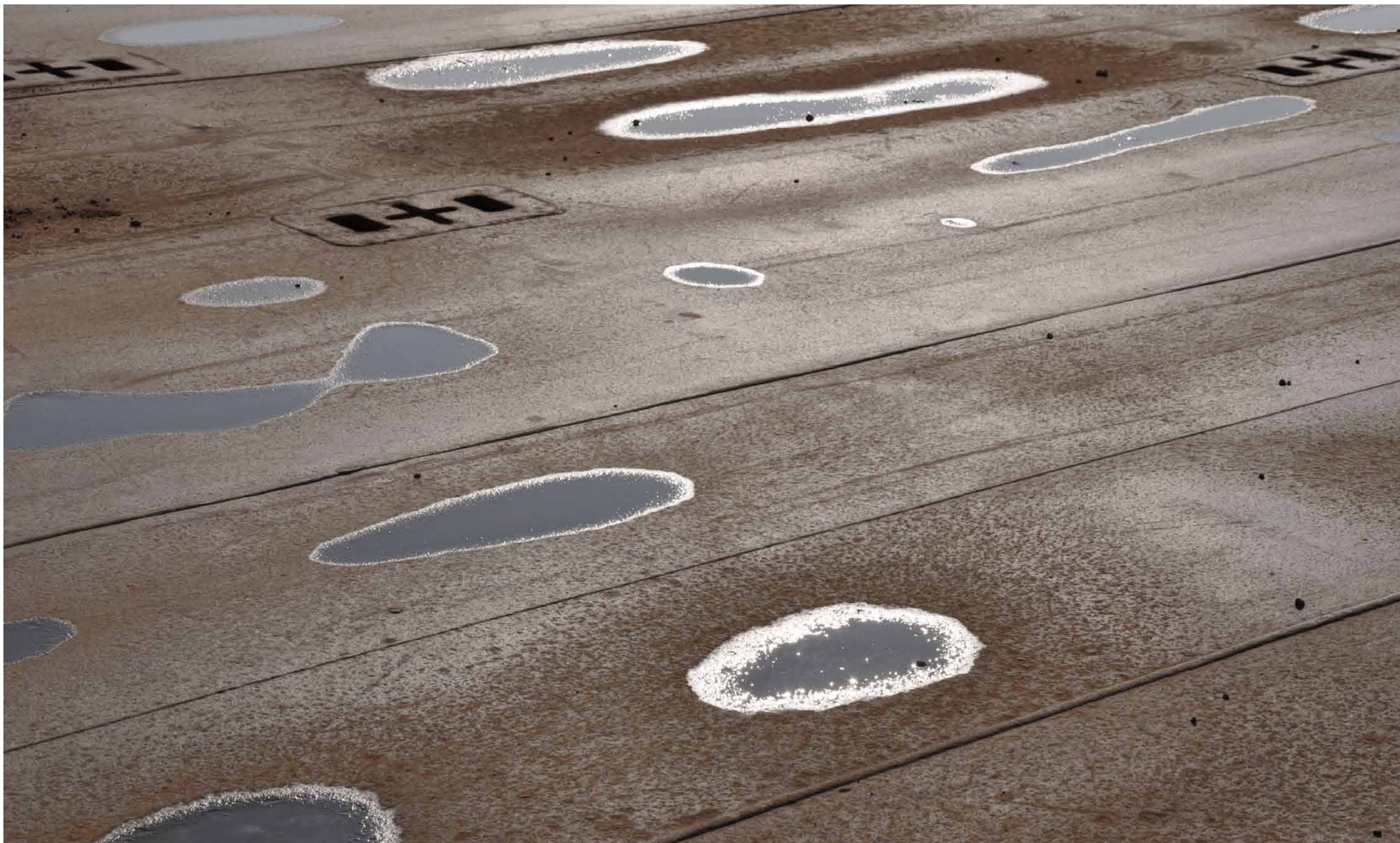




















REMNANTS OF OIL & GAS IN TUK



















# WHOLE ARCTIC CATALOG

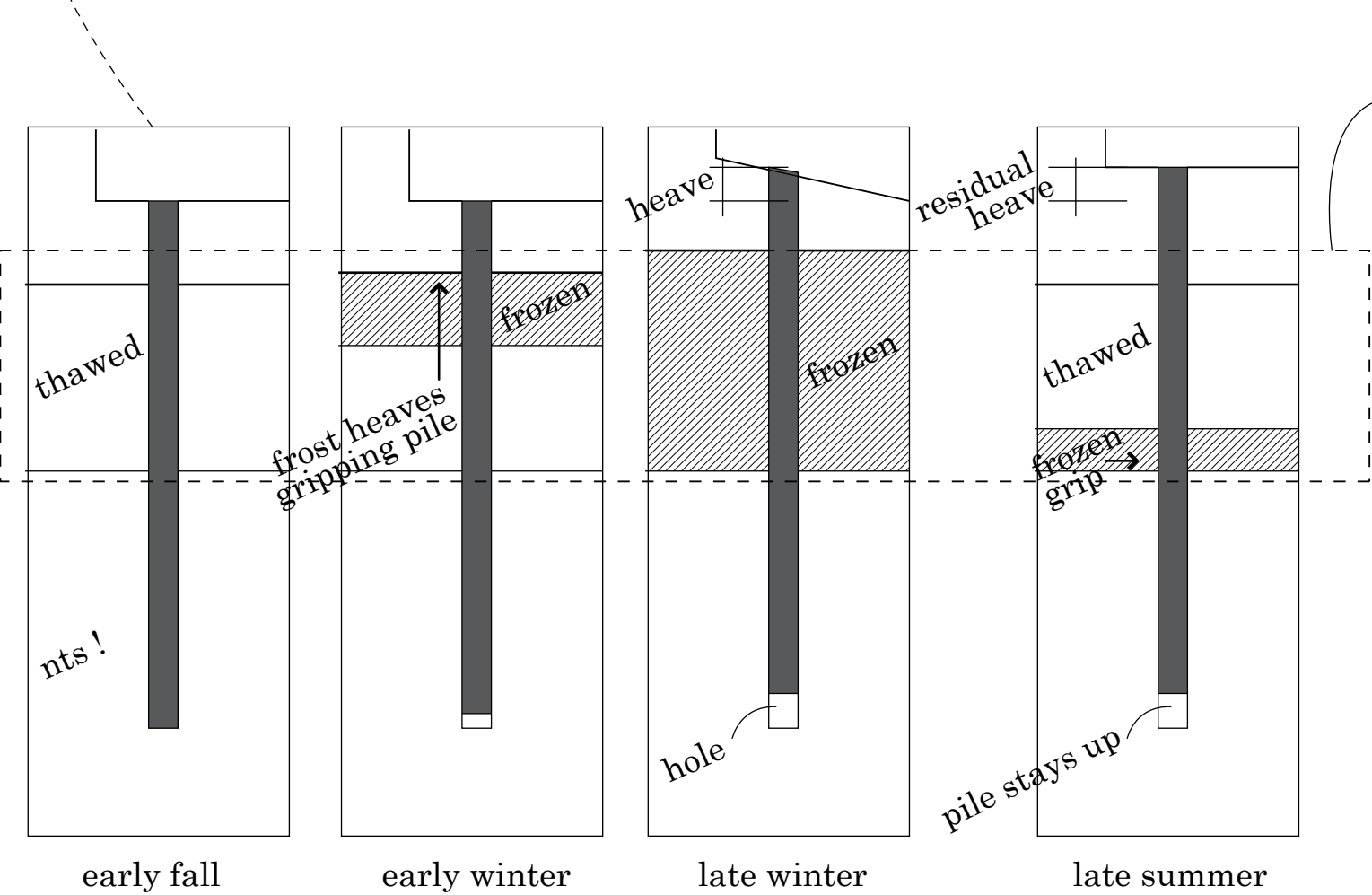
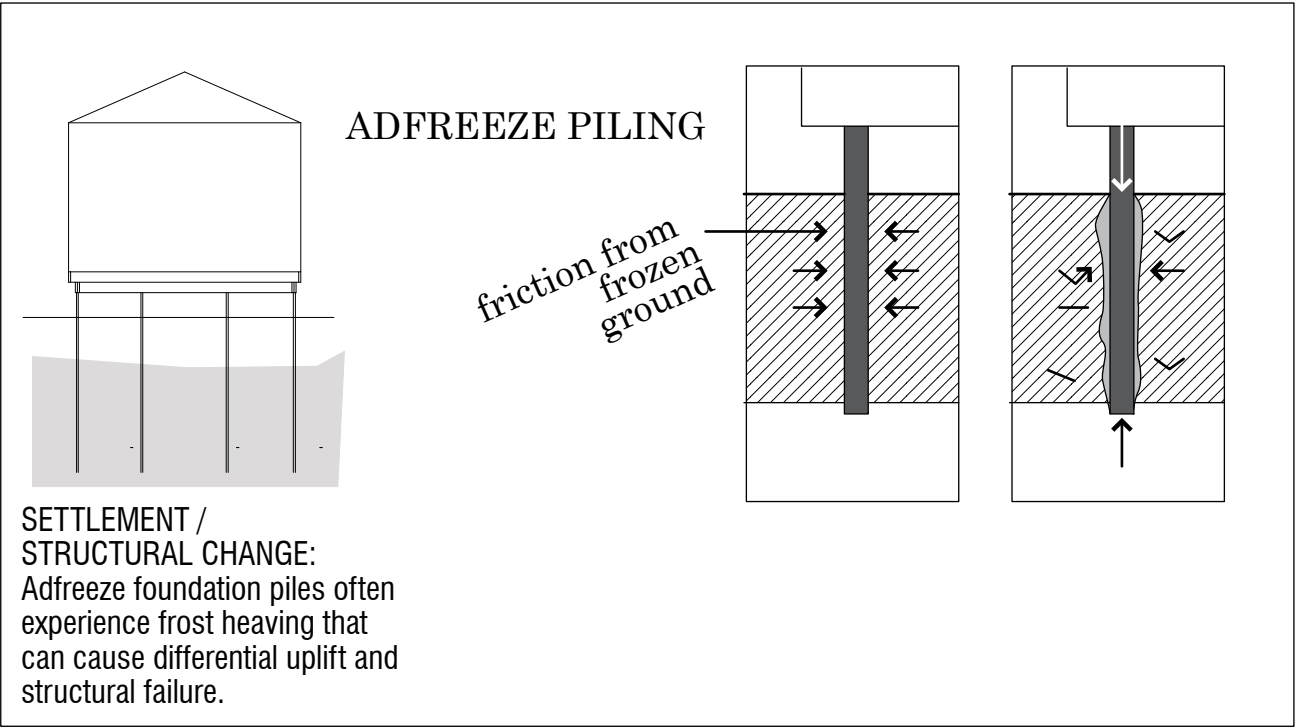
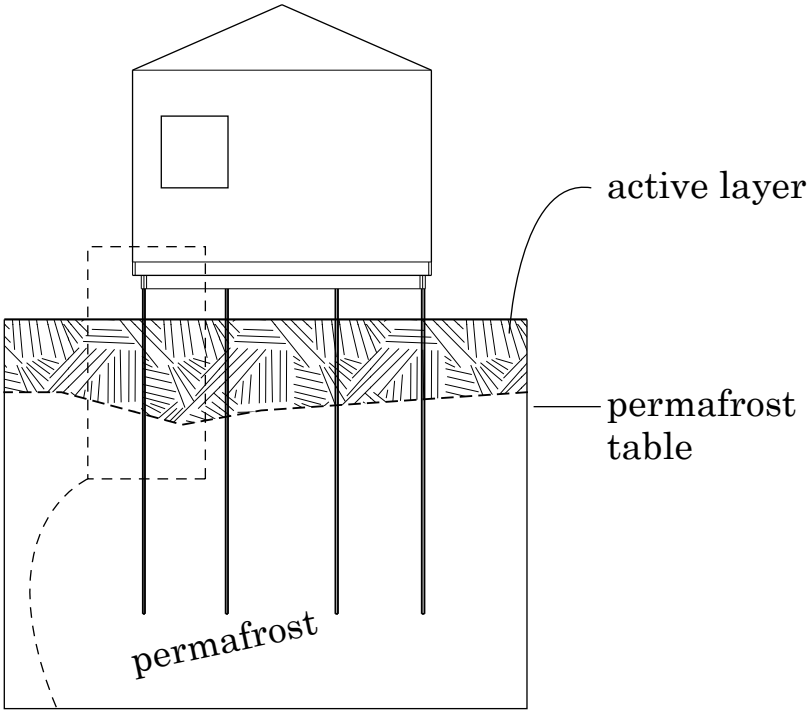
*access to tools*

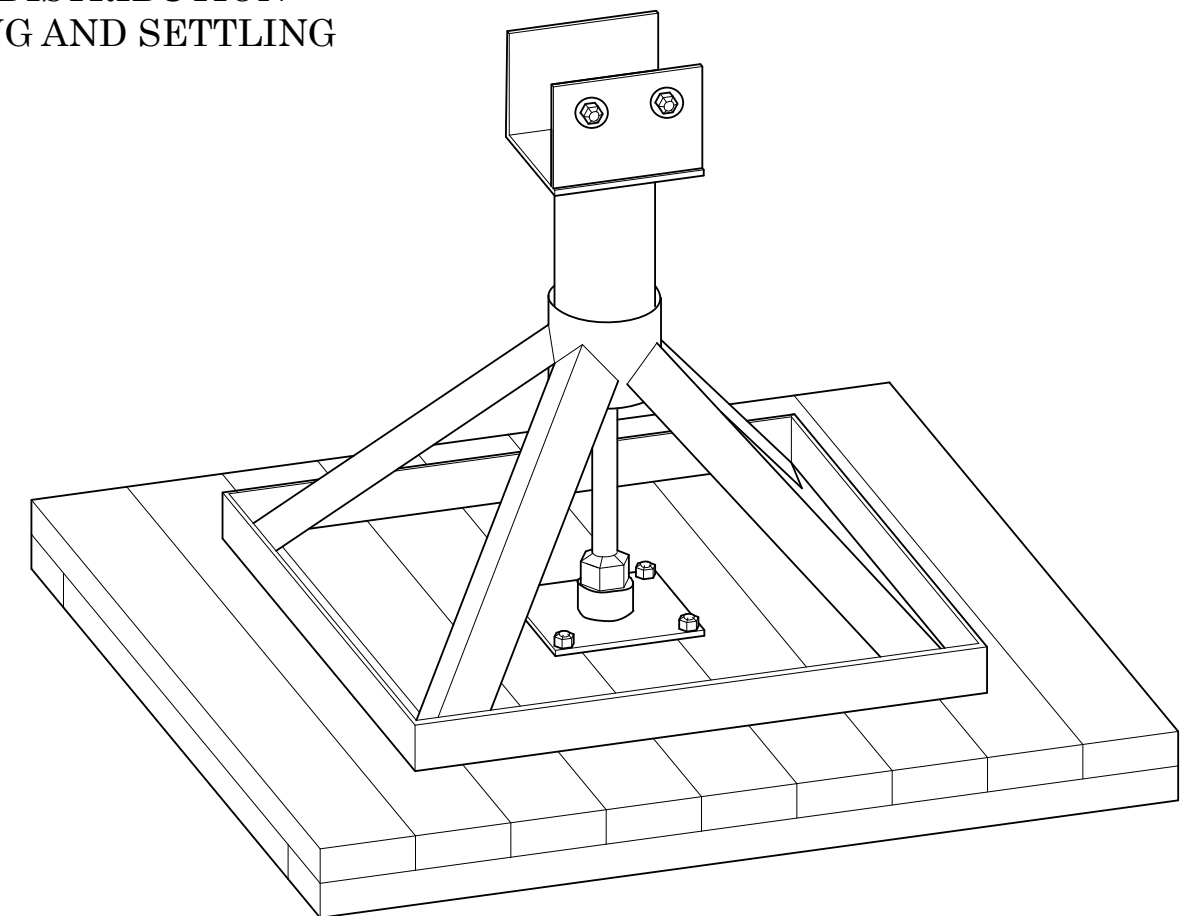
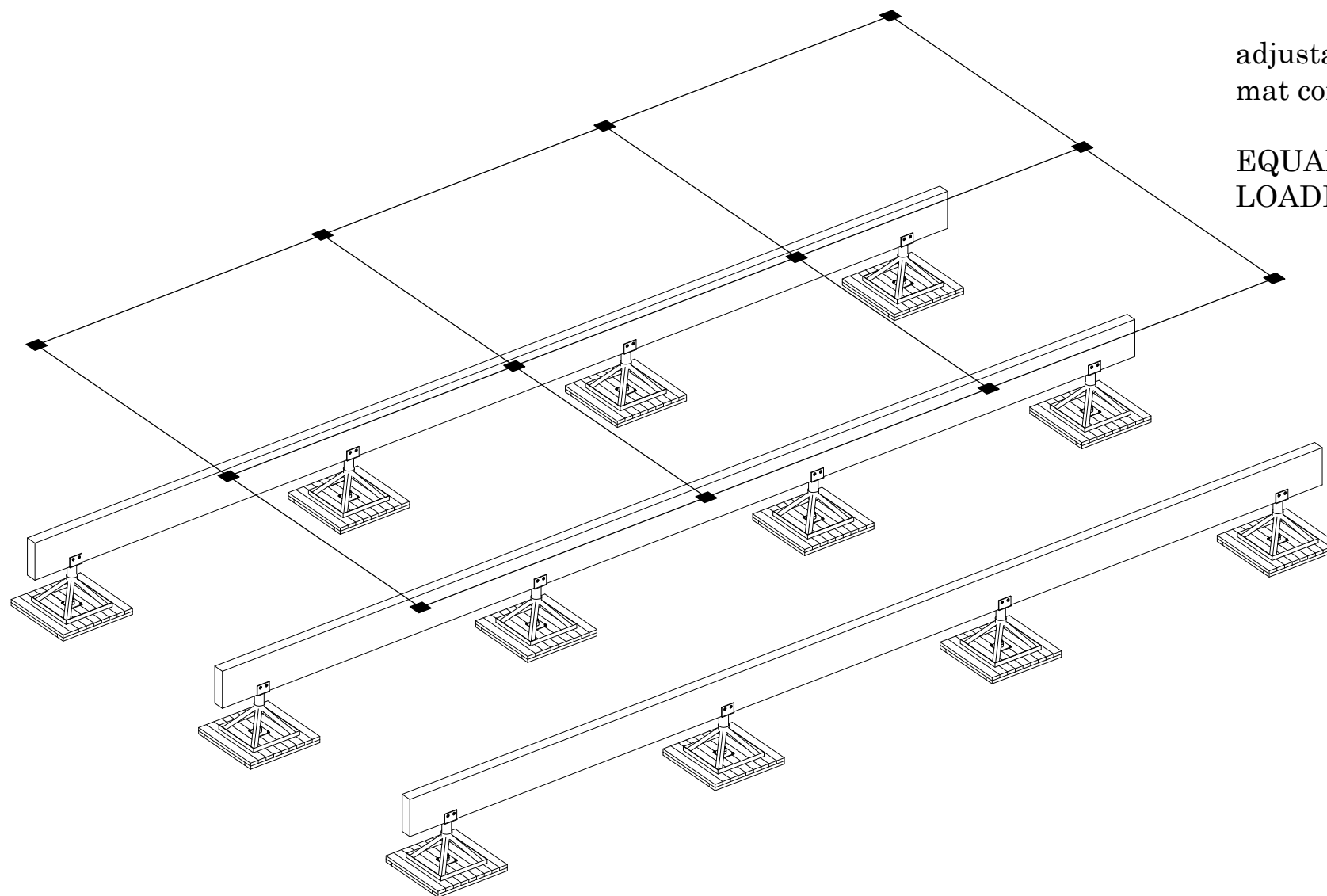
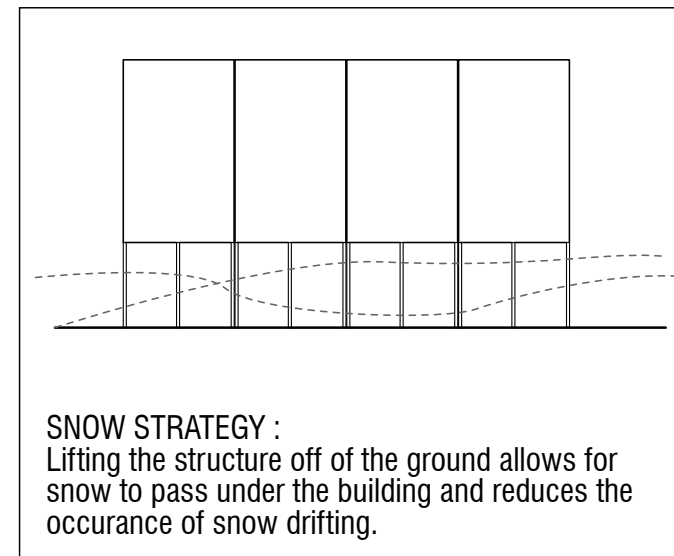
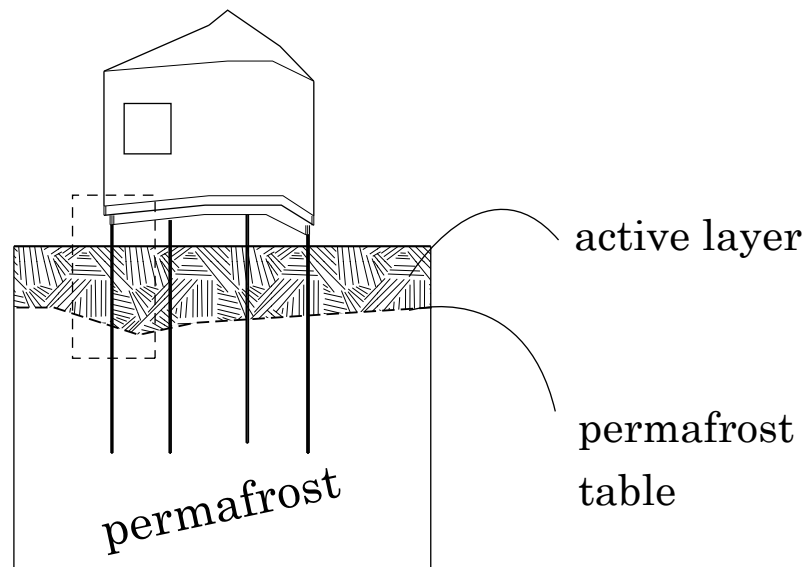


FALL 2010  
\$10 CAD

PERMAFROST  
ARCTIC CHALLENGES:

- Wood pile decay
- Structural retrofits
- Differential settlement





## SCREW-JACK FOUNDATION

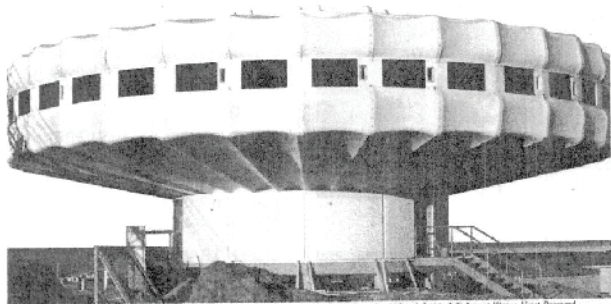
Ability to find stability on an uneven groundplane

Screw jack adjusts for differential settlement maintaining a mat condition

Screw-jacks are adjusted by local population to account for heave in the winter and drop in the summer



1973 IGLOOLIK RESEARCH  
LABORATORY, IGLOOLIK, NV  
**What FRP**  
can do for buildings.



**INTRODUCTION**

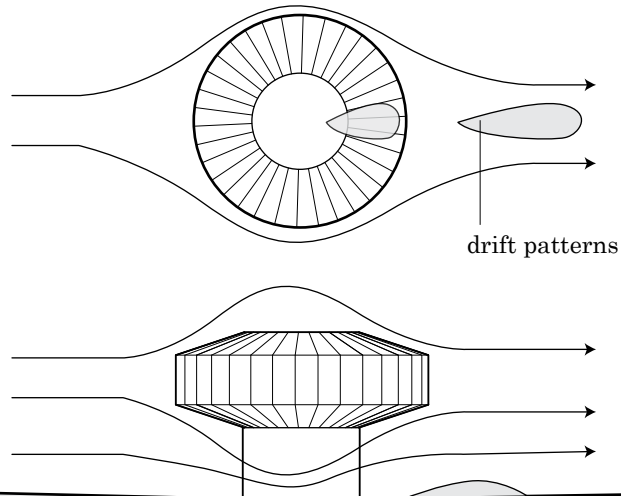
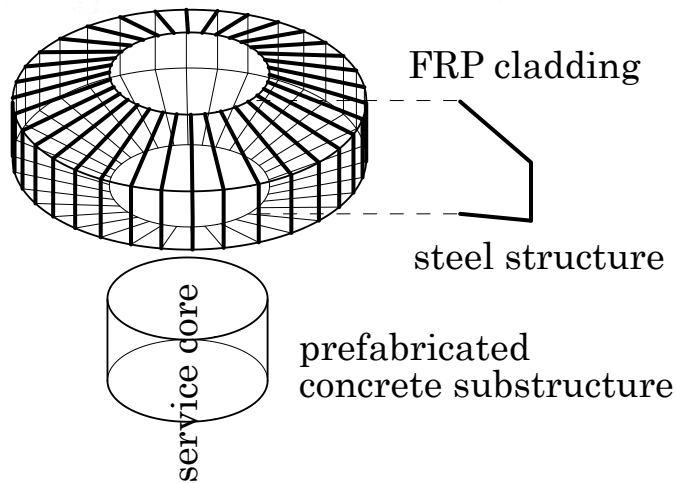
This architectural manual, has been prepared for the architect, designer or fabricator who is interested in FRP (Fiberglass Reinforced Plastic) in architectural construction. Rather than an exhaustive treatise, the manual is intended to introduce the important fundamental areas dealing with FRP in buildings and structures.

FRP materials are composites in which glass fibers impart strength and stiffness, while polyester resin provides the matrix between the glass fiber filaments, bonding them

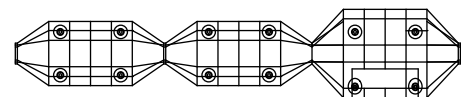
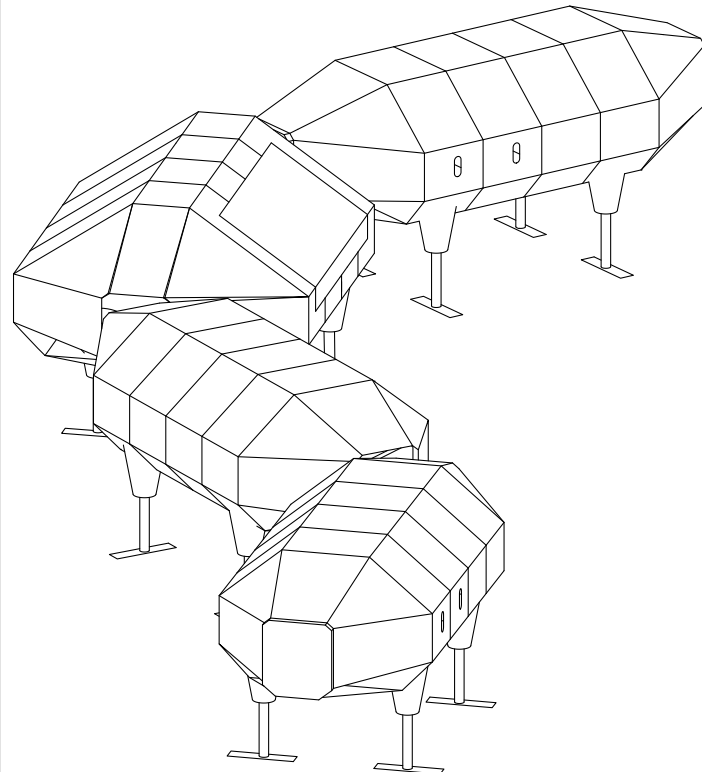
together and distributing applied loads to the reinforcing fibers.

Considerable innovation has already taken place in the use of FRP in the Canadian construction industry. Attachment methods have been developed which overcome differential thermal expansion between cladding panels and their supporting structures. Surface finishing techniques have been developed which have greatly improved the weathering characteristics of FRP panels. FRP panels have become an integral part of the building design and not just alternative cladding.

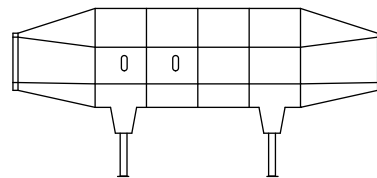
arctic innovations ?



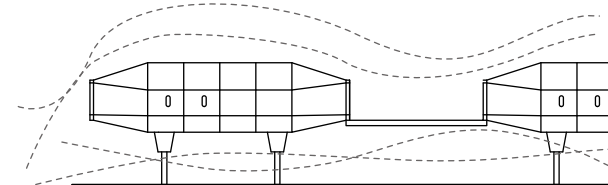
2007 HALLEY VI RESEARCH BASE, ANTARCTIC



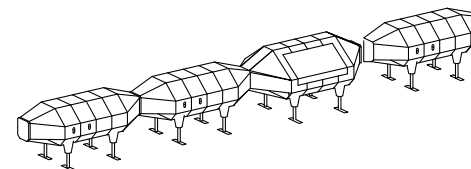
the repetition of a single unit for six structures and only one varying unit as the social space allows for repetitive construction methods. Materials arrive by boat from South Africa.



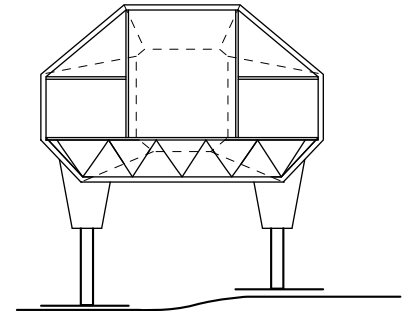
adjustable jack-up legs allow the pods to rest lightly on the ground



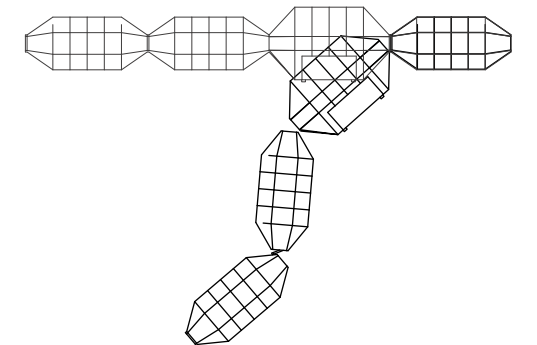
Raised off of the ground and containing the open space between two pods, reduces snow buildup from perpendicular winds.



A linear deployment traps air between the pods as well as the ability to thermally seal one unit off from the rest in case of emergency.



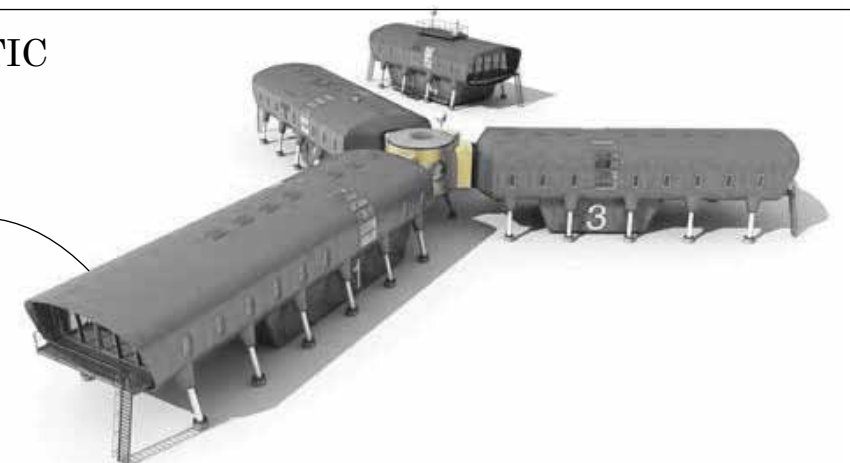
jack-up legs are recalibrated each season as the sea ice changes. As well, the pods become mobile through the use of skis on their footing.



The use of a regularized structural steel space frame allows for a lightweight, easily deployable structure that properly counters the weight capacities of the sea ice.

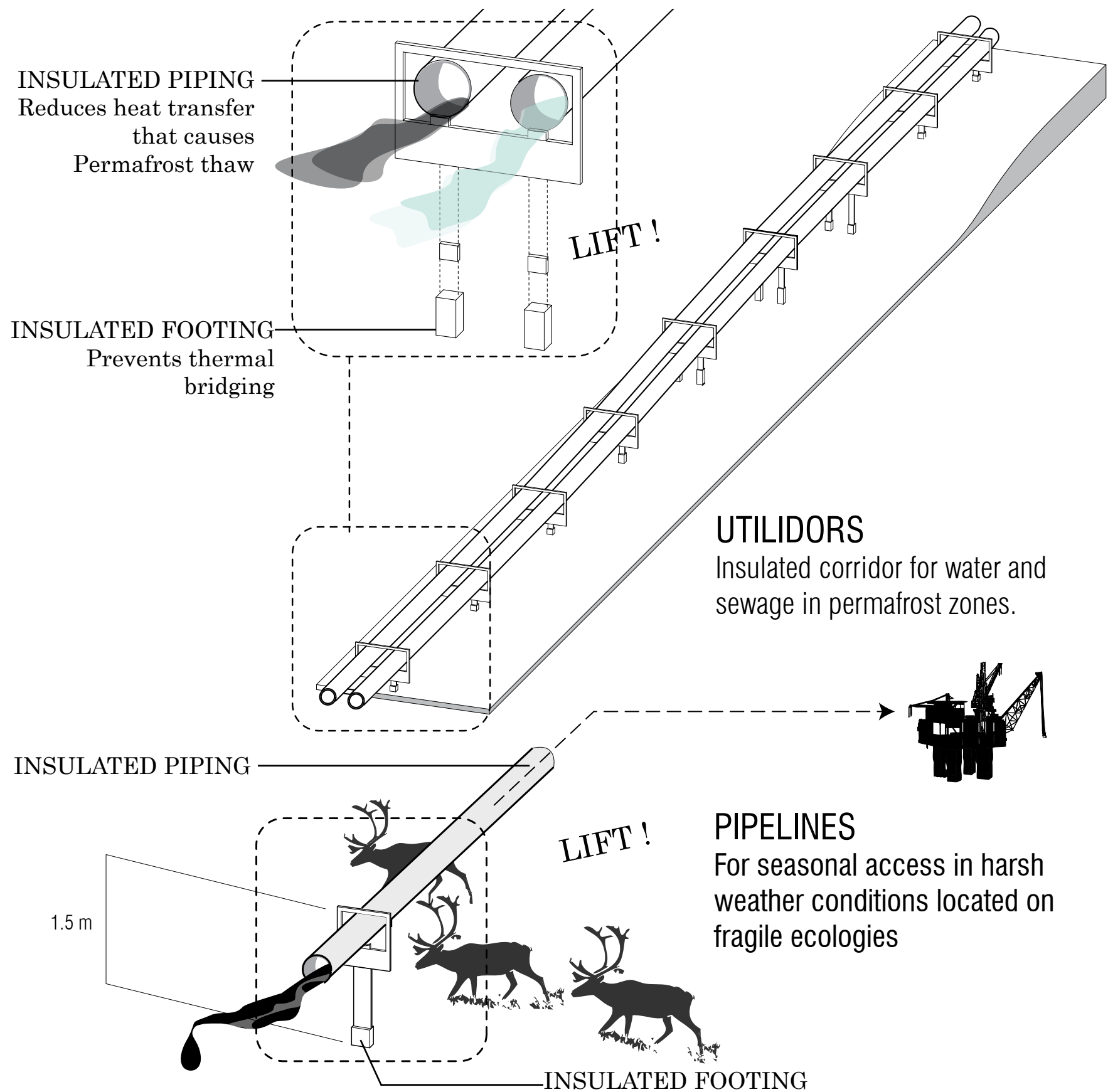
2011 SPANISH ANTARCTIC BASE, LIVINGSTONE ISLAND, ANTARCTIC

**MODULAR FRP MONOCOQUE RINGS !**  
tubular geometry resists need for additional steel structure





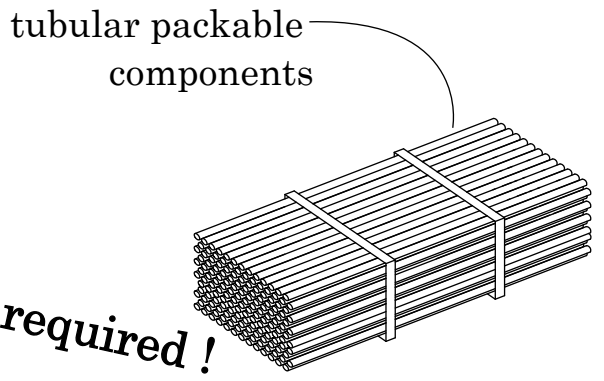
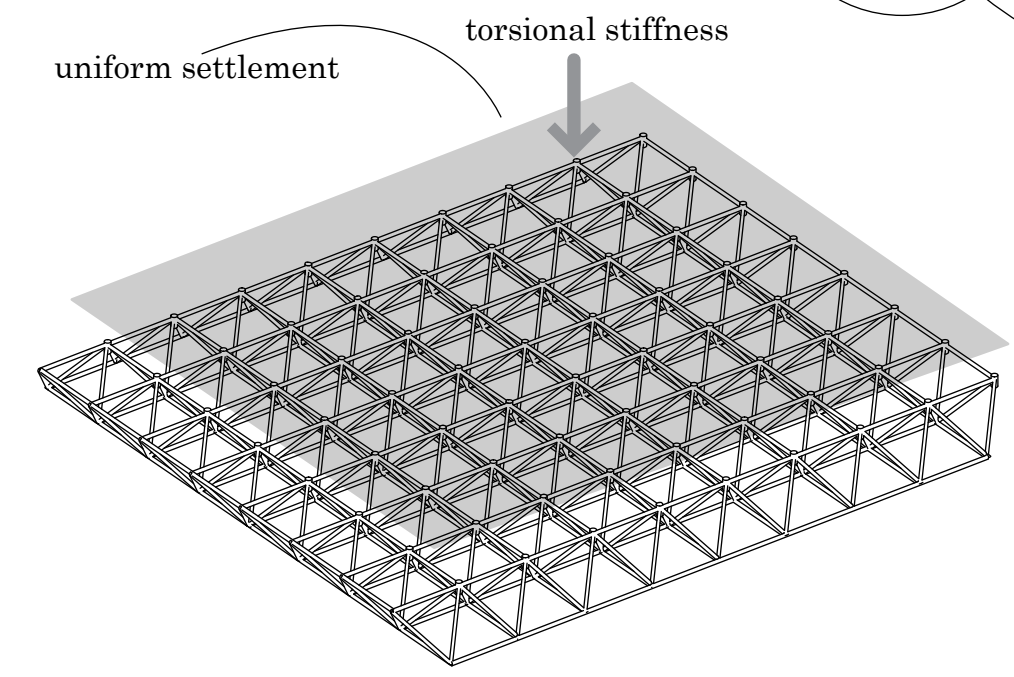
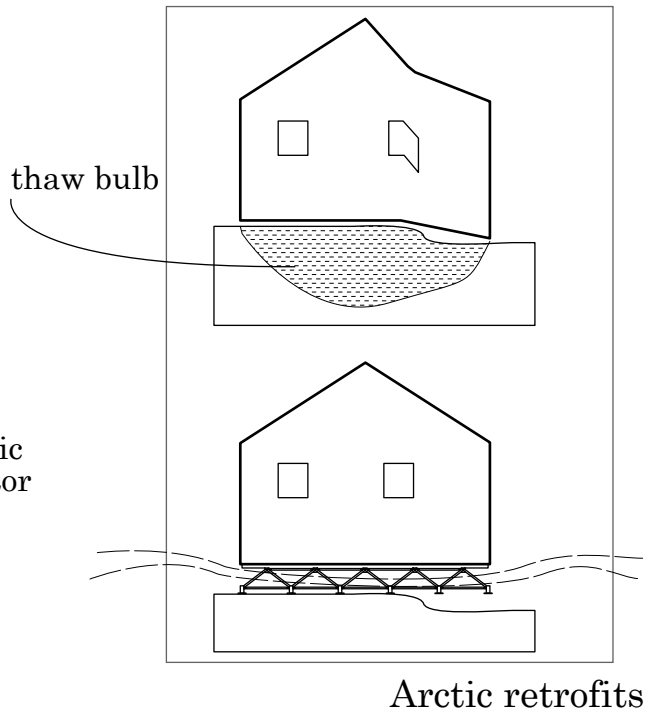
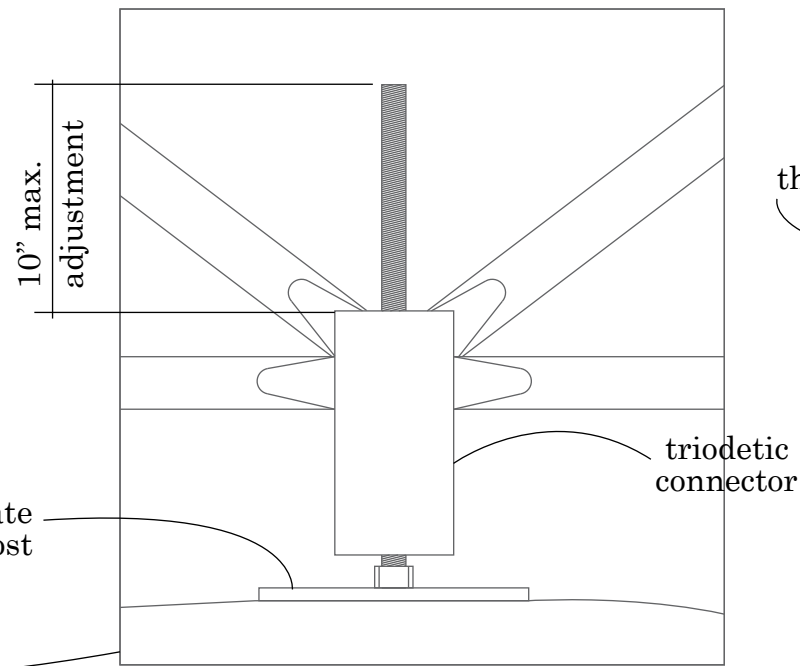
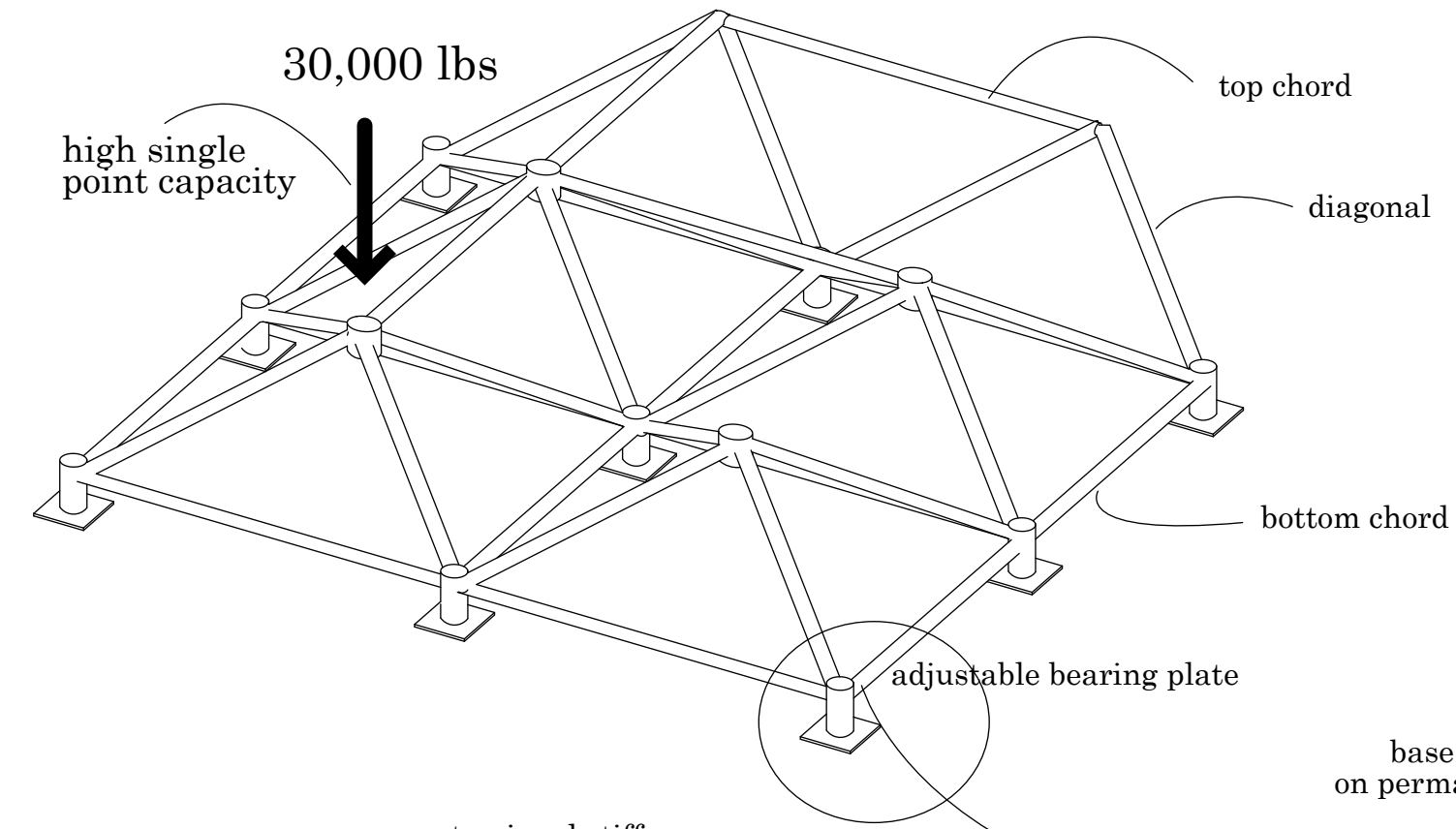
PERMAFROST STRATEGIES



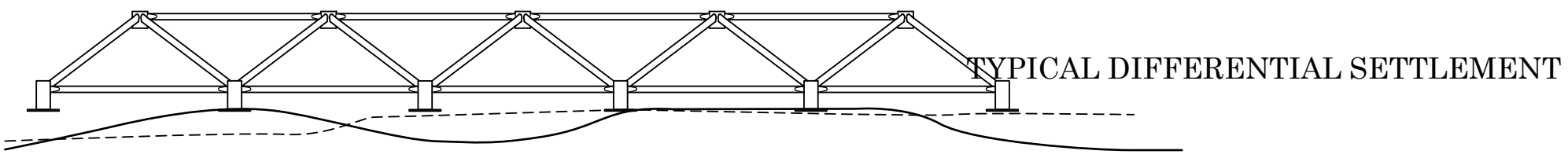


TRIODETIC SPACE FRAME

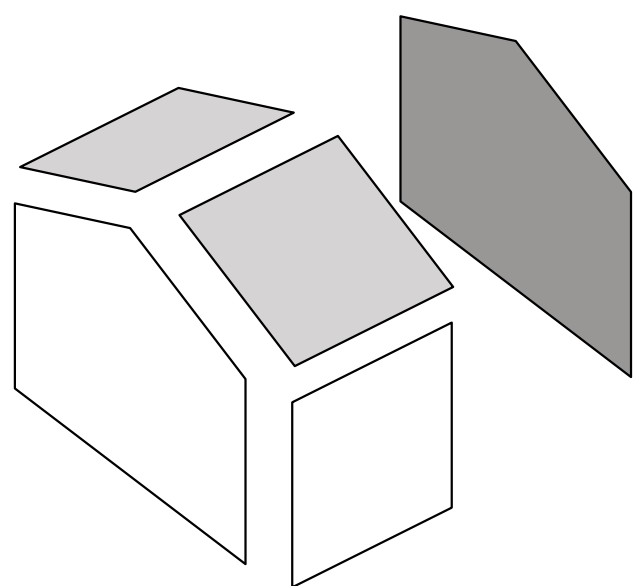
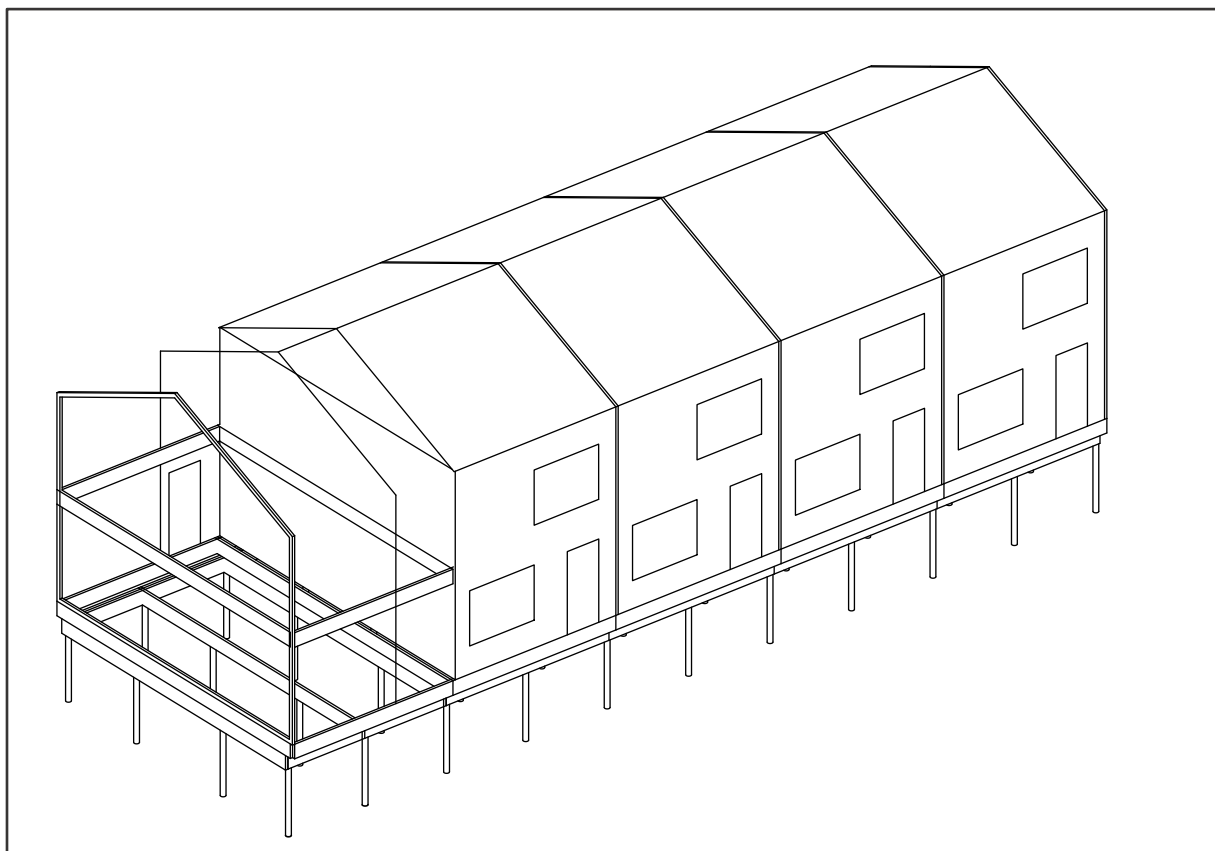
Allows for even settlement and ground shifting  
Moves uniformly on a shifting groundplane



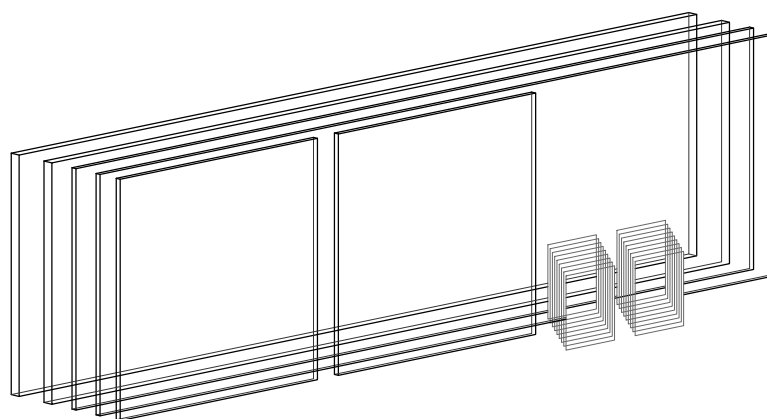
no skilled labour required !







**REPETITIVE MODULES**  
rapid construction and efficiency



**FLAT-PACK COMPONENTS**  
ease of transportation  
on-site fabrication by unskilled labour  
ensures construction quality

## SIPS

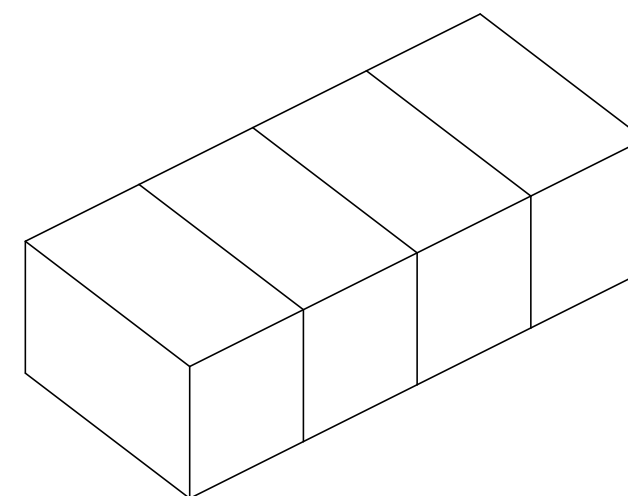
(STRUCTURALLY INSULATED PANELS)

### MATERIAL LOGISTICS:

Prefabrication of SIP panels and repetitive modules allows for rapid construction and increasing efficiency. Materials arrive on a barge from Hay River

### MATERIAL INNOVATION:

The use of flat-pack components can allow for an ease of transportation while prefabrication ensures construction quality and consistency in these remote, and often unskilled areas.



**THERMAL STRATEGY:**  
units are constructed linearly, to reduce exposure of the envelope to extremes on the exterior.

## STRUCTURAL SPANNING SKINS

Rapidly deployable, easy assembly

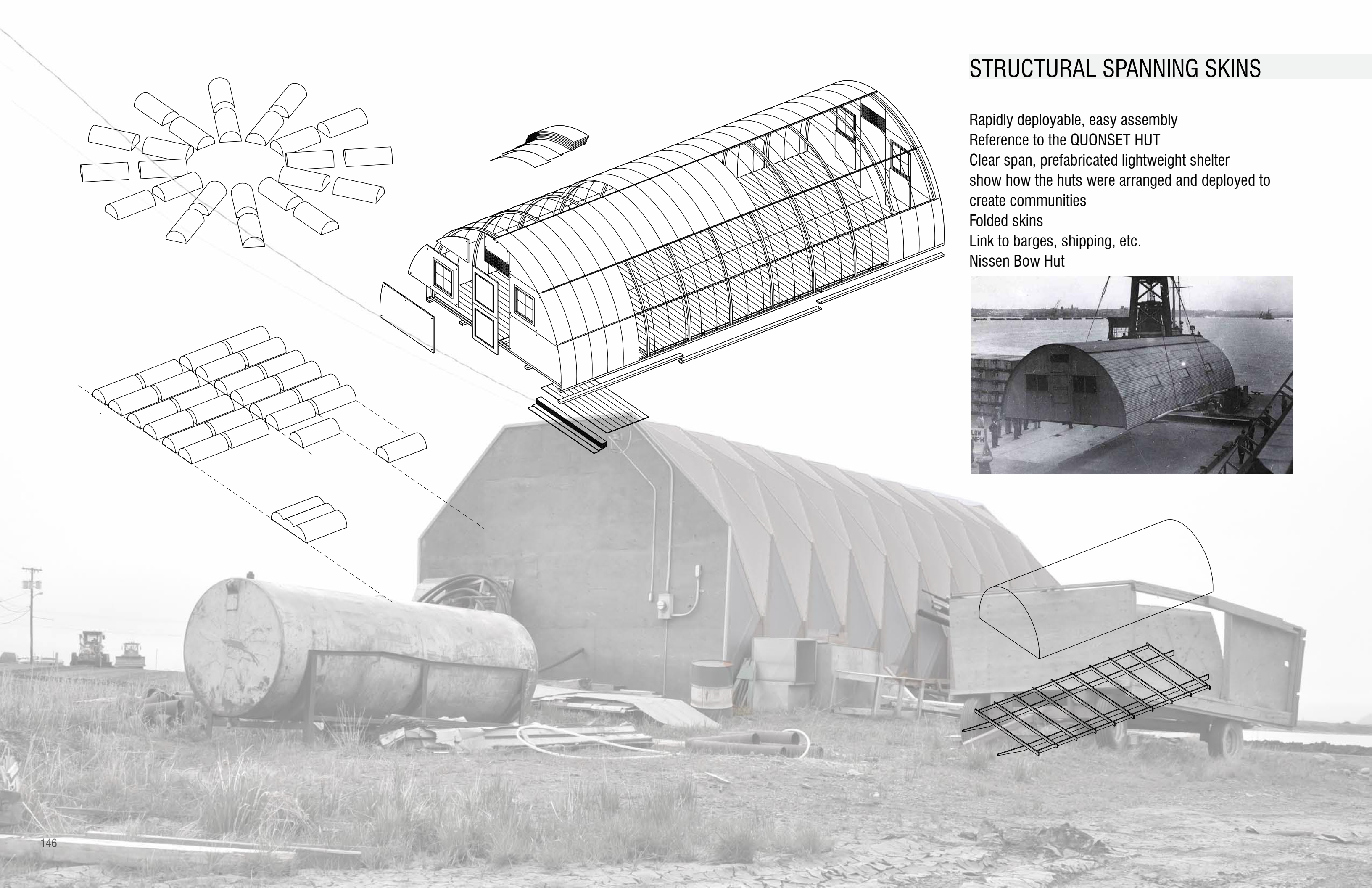
Reference to the QUONSET HUT

Clear span, prefabricated lightweight shelter  
show how the huts were arranged and deployed to  
create communities

Folded skins

Link to barges, shipping, etc.

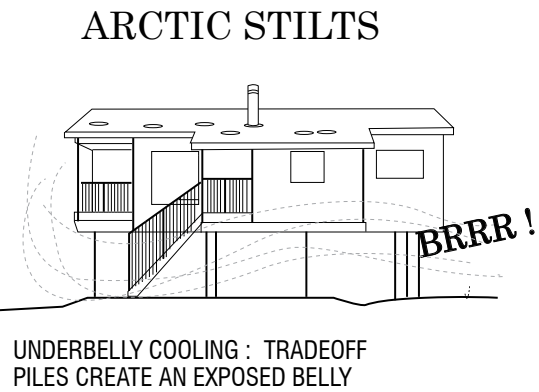
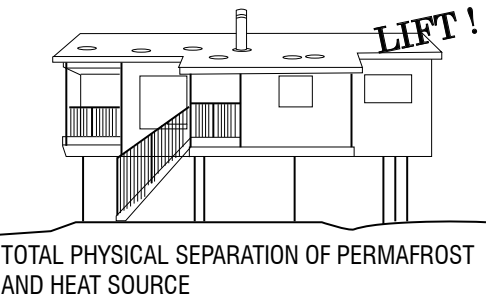
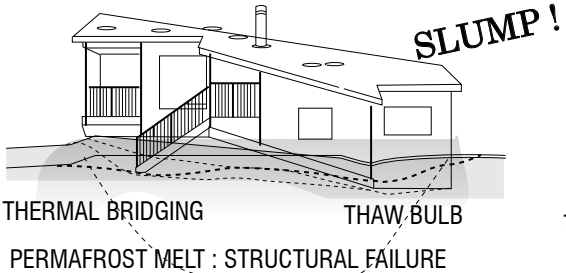
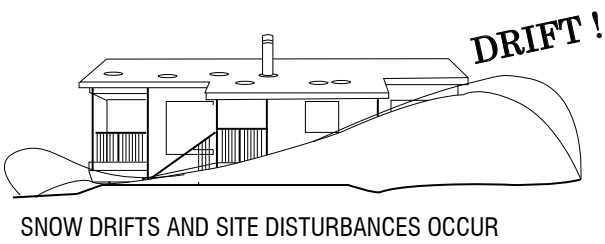
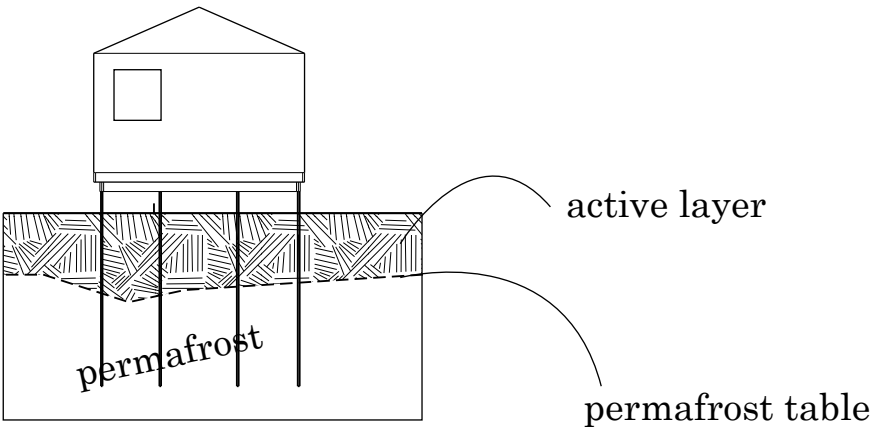
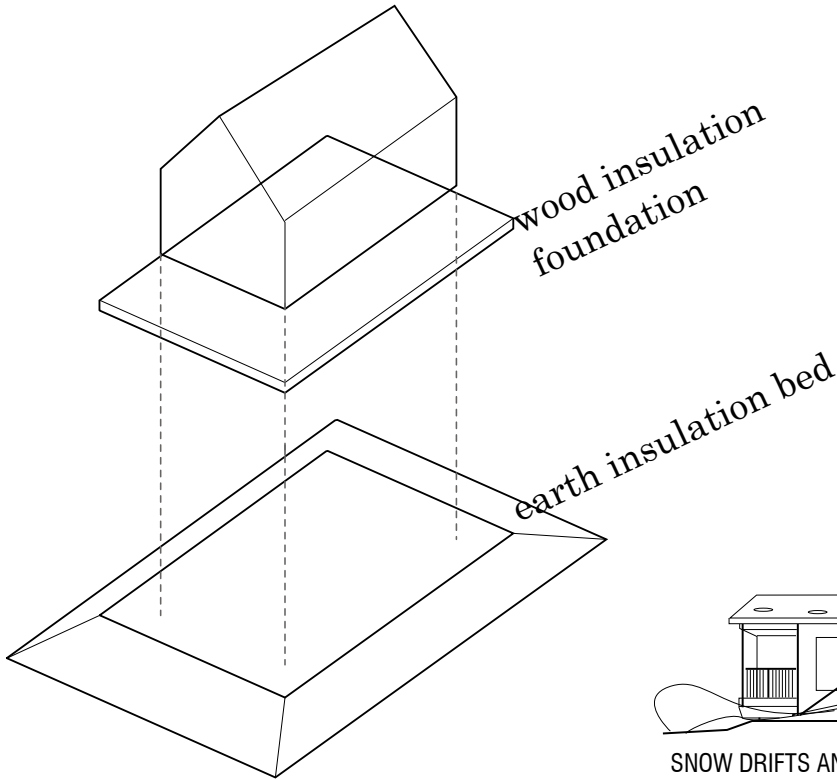
Nissen Bow Hut





PERMAFROST\_SURFACE STRATEGIES

Insulate the ground



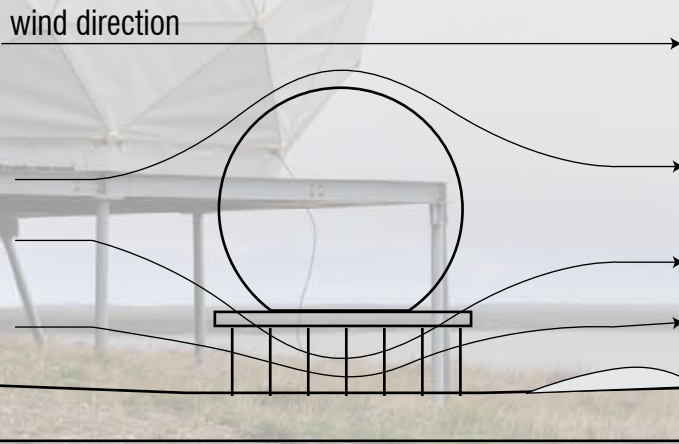
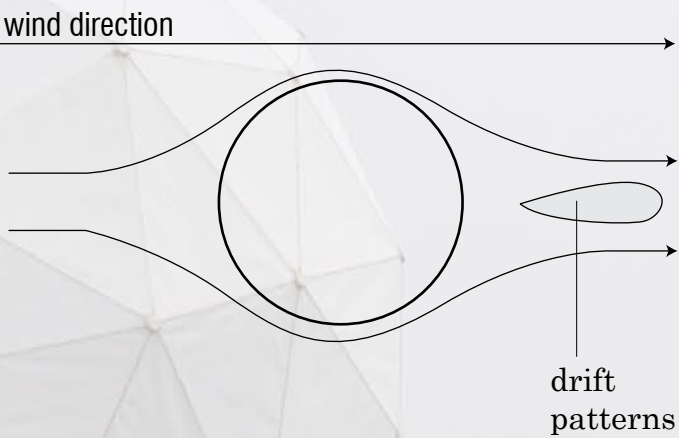


# DEW LINE RADAR STATIONS

## \_GEODESIC RADOMES

- Structurally strong
- Lightweight
- Rapidly deployable
- Portable and adaptable
- Self-bracing triangles
- Economical structure
- No internal supports
- Withstands extreme Arctic conditions
- FLATPACK construction: 1 plane, 1 engineer
- Untrained labour

RHOMBIC TRIACONTAHEDRON

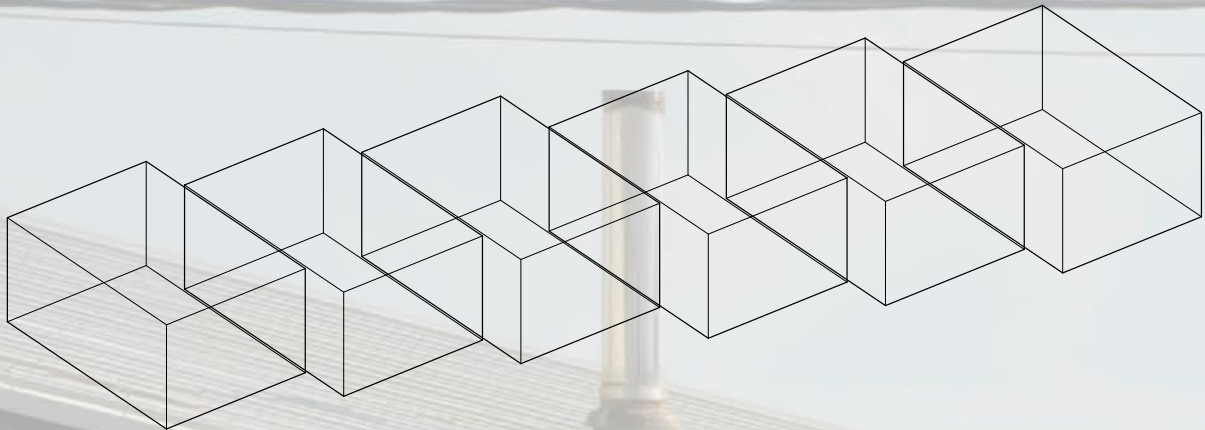


SPHERICAL  
SHELL  
  
OPEN CRAWL  
SPACE



# GOVERNMENT HOUSING

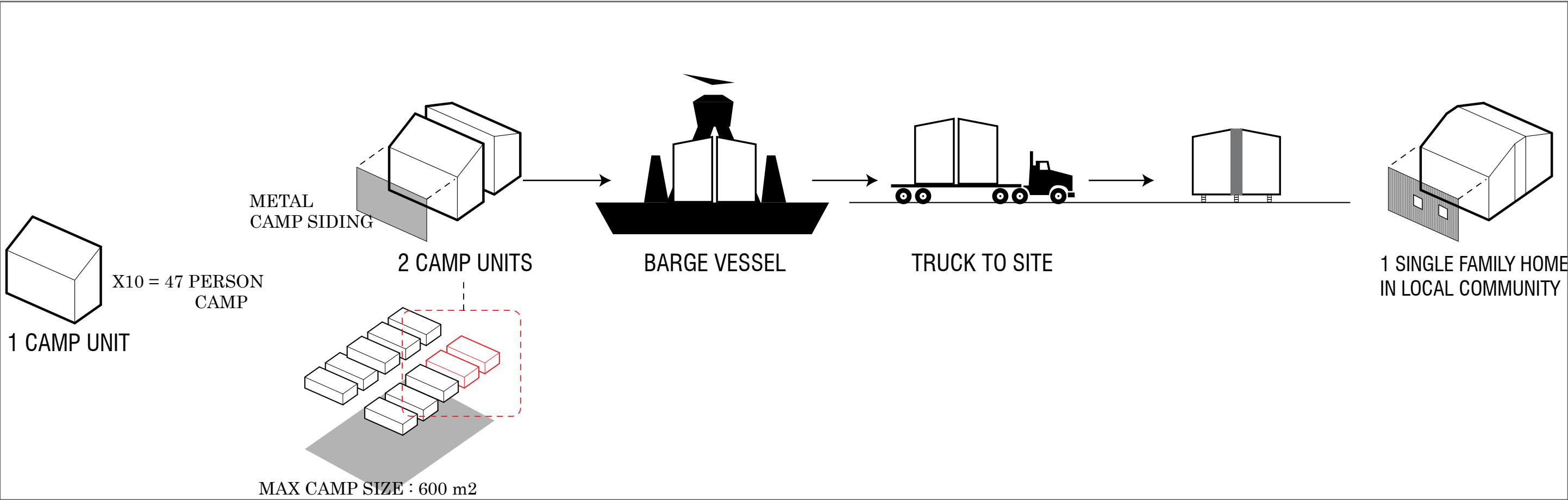
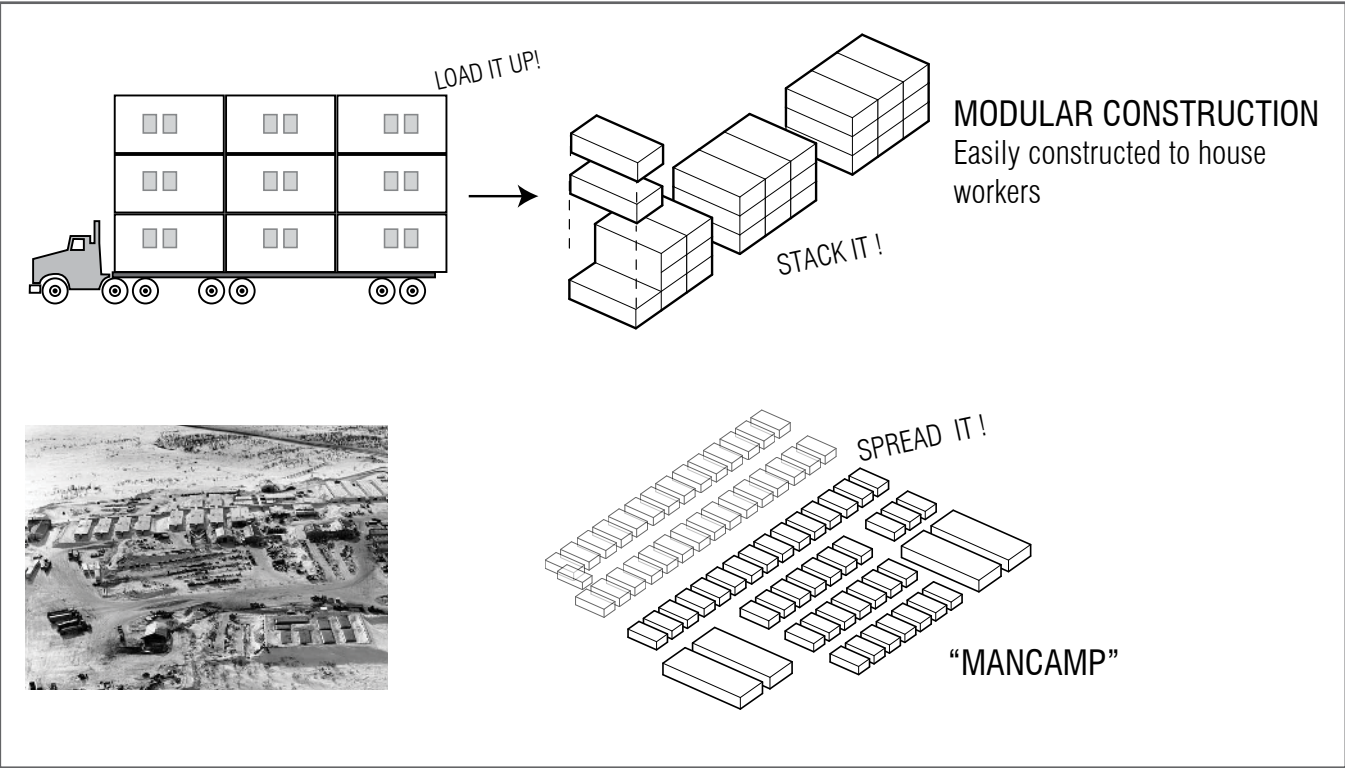
Repetitive development  
demonstrates periods of urbanization and past  
failures at Arctic urbanism



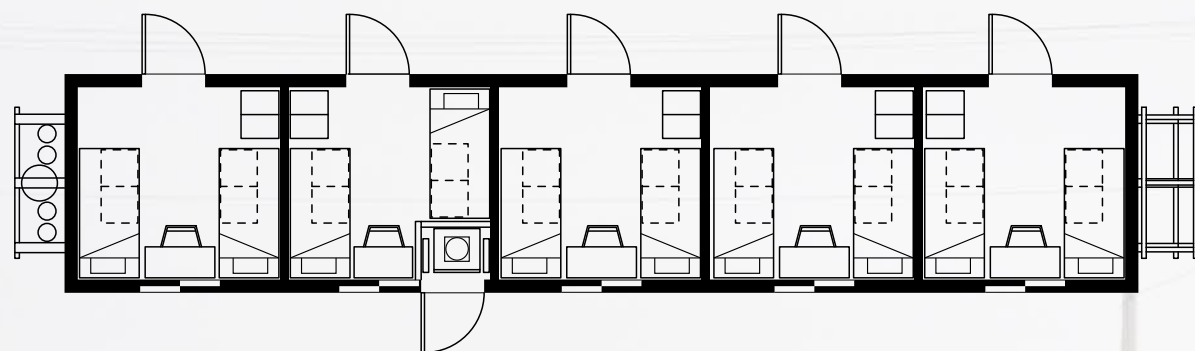
GOVERNMENT ROW HOUSING TYPOLOGY



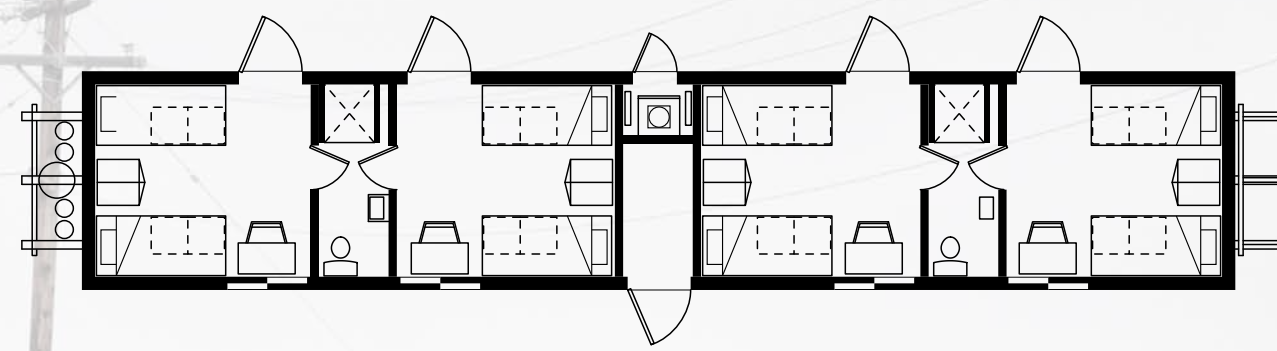
THE NOVEL PROJECT :  
ADAPTABLE GAS INFRASTRUCTURES







10 PERSON SLEEPER UNIT



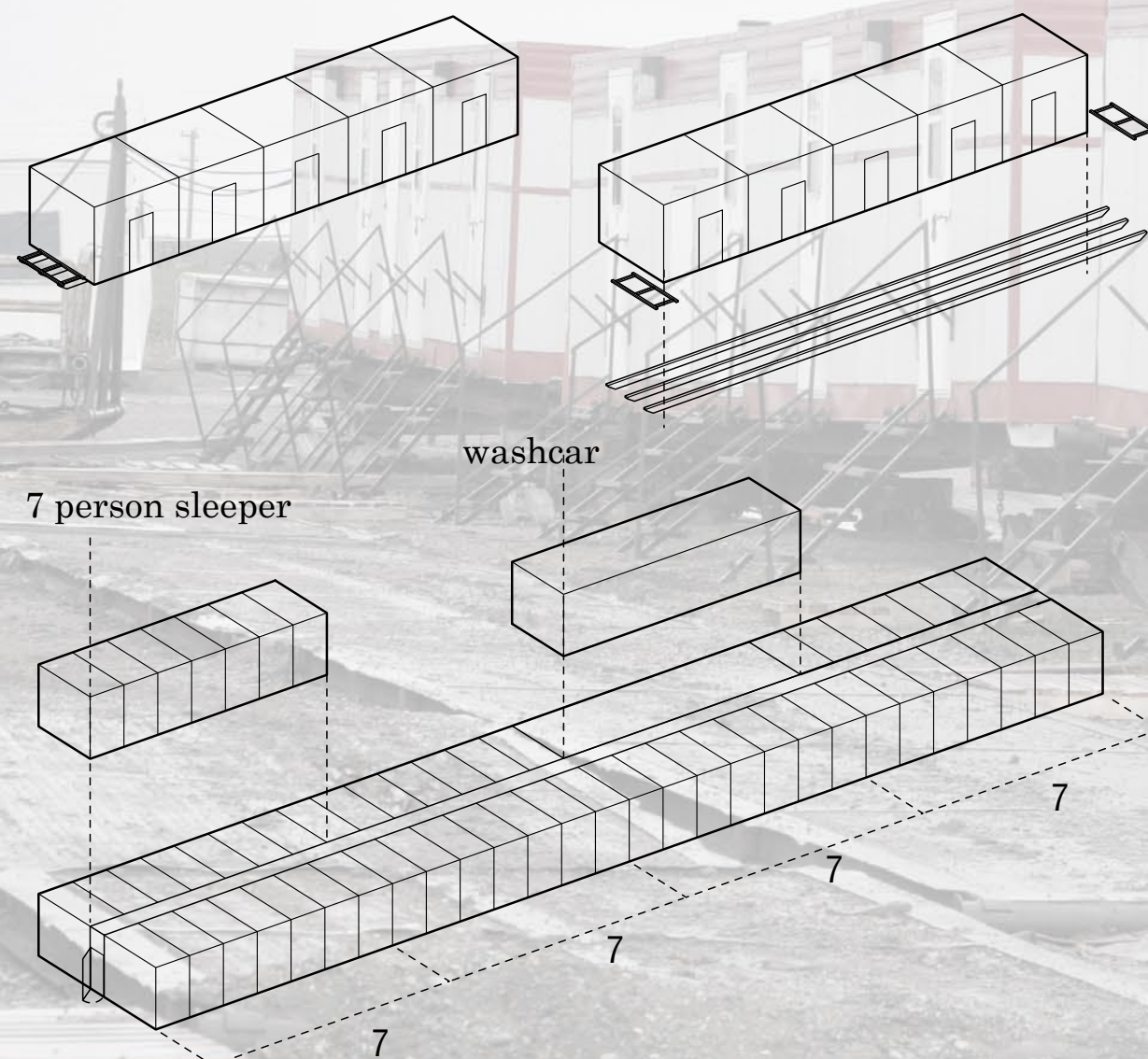
8 PERSON SLEEPER / WASHCAR

## ATCO\_PORTABLE MANCAMP SOLUTIONS

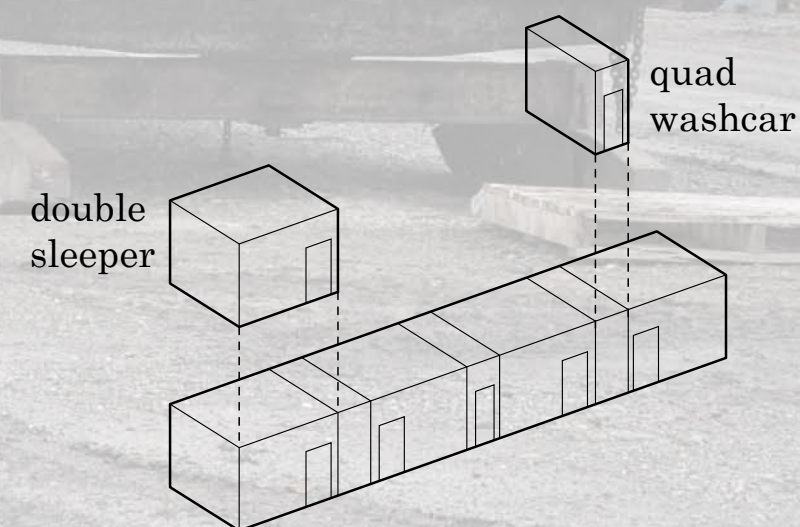
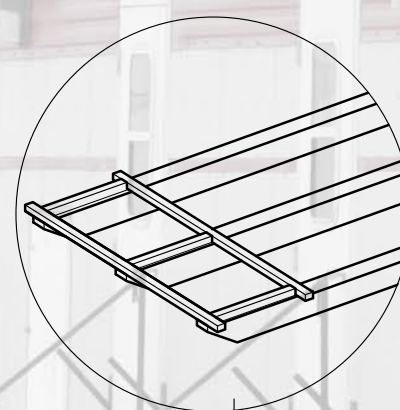
Modular workforce housing for the oil and gas industry

Heavy duty steel skid frames with modular ski double plywood floor

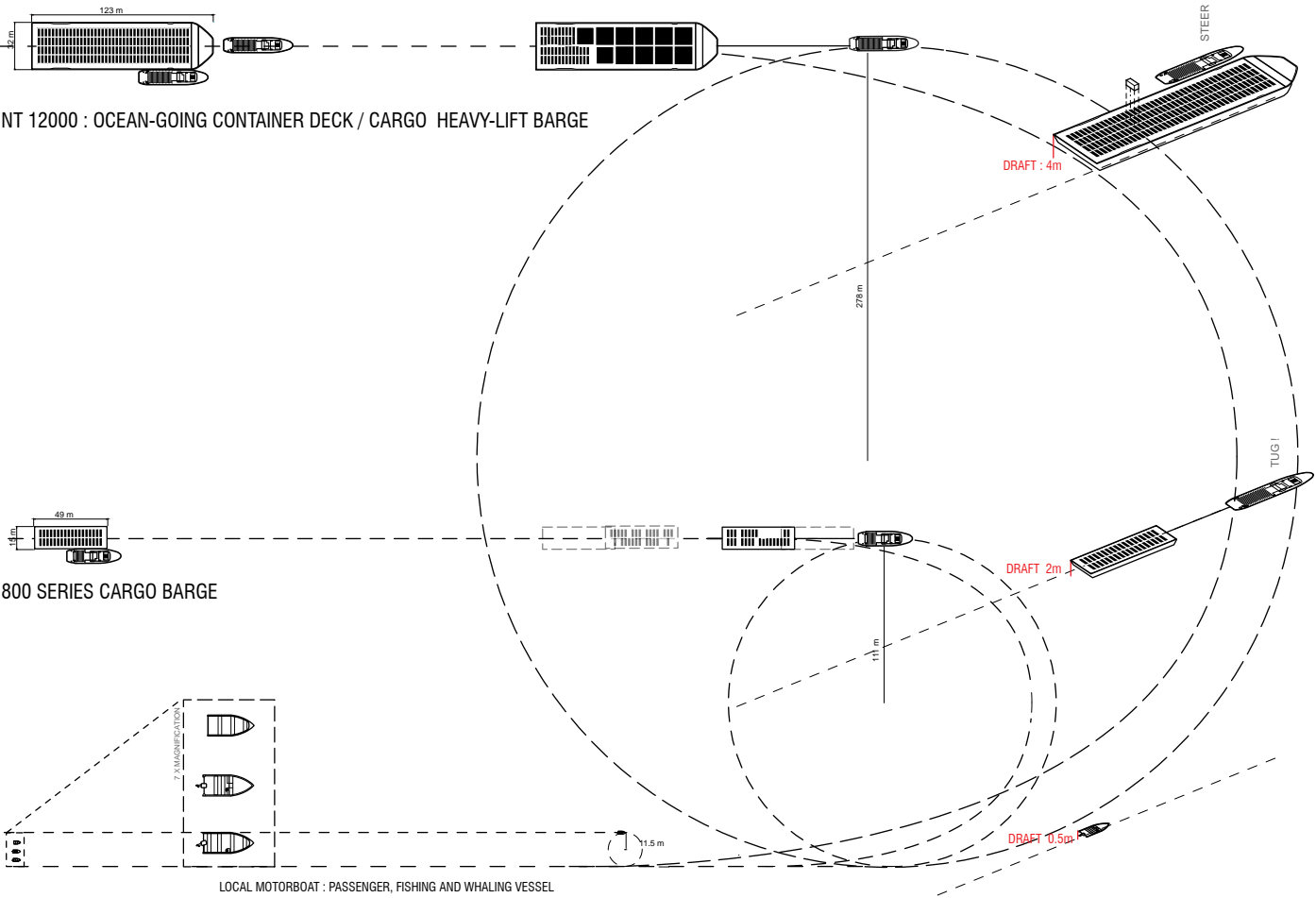
Self-contained water storage tanks



49 PERSON DORMITORY COMPLEX

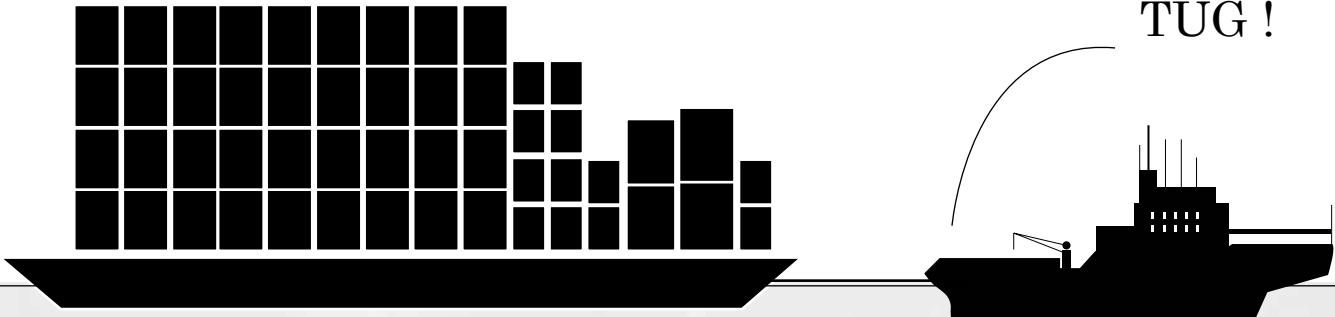
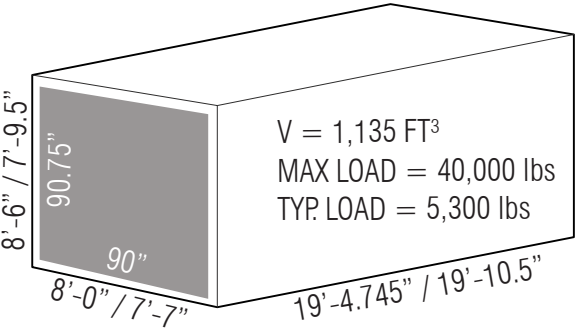


THE VESSEL

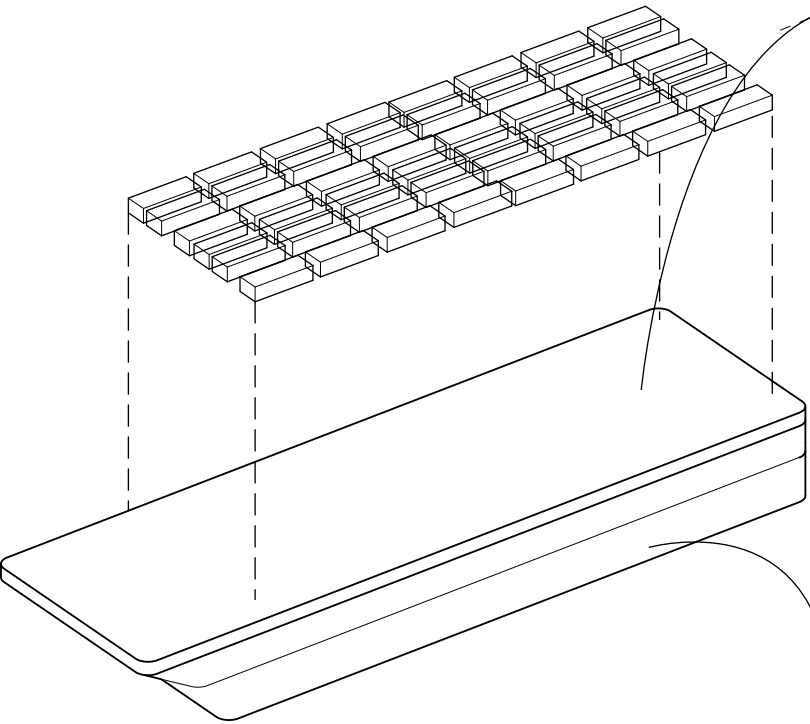


SHIPPING CONTAINERS :  
SUPPLY VESSELS

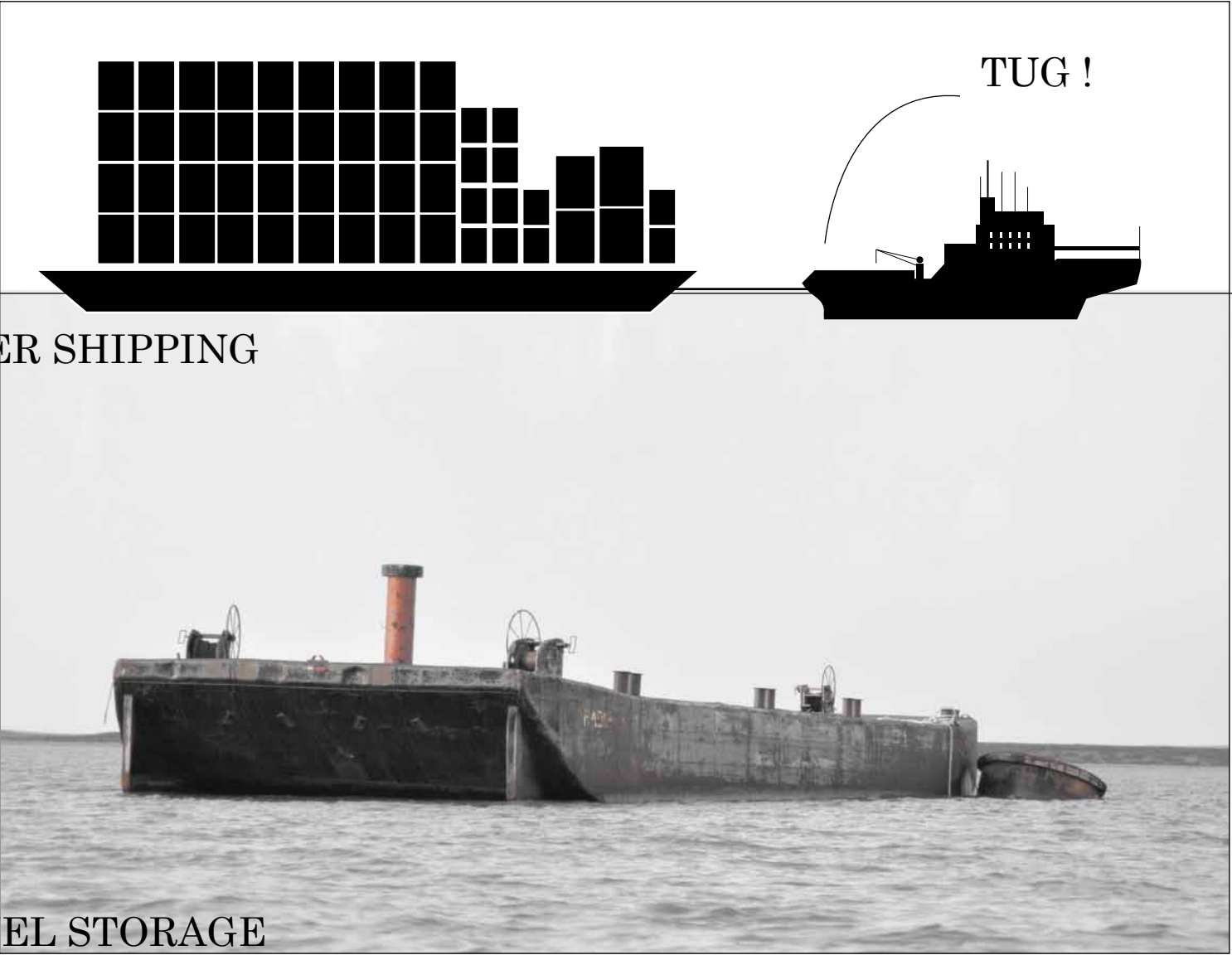
Manage the flow of goods and wastes in and out of Tuktoyaktuk's NTCL shipping port.



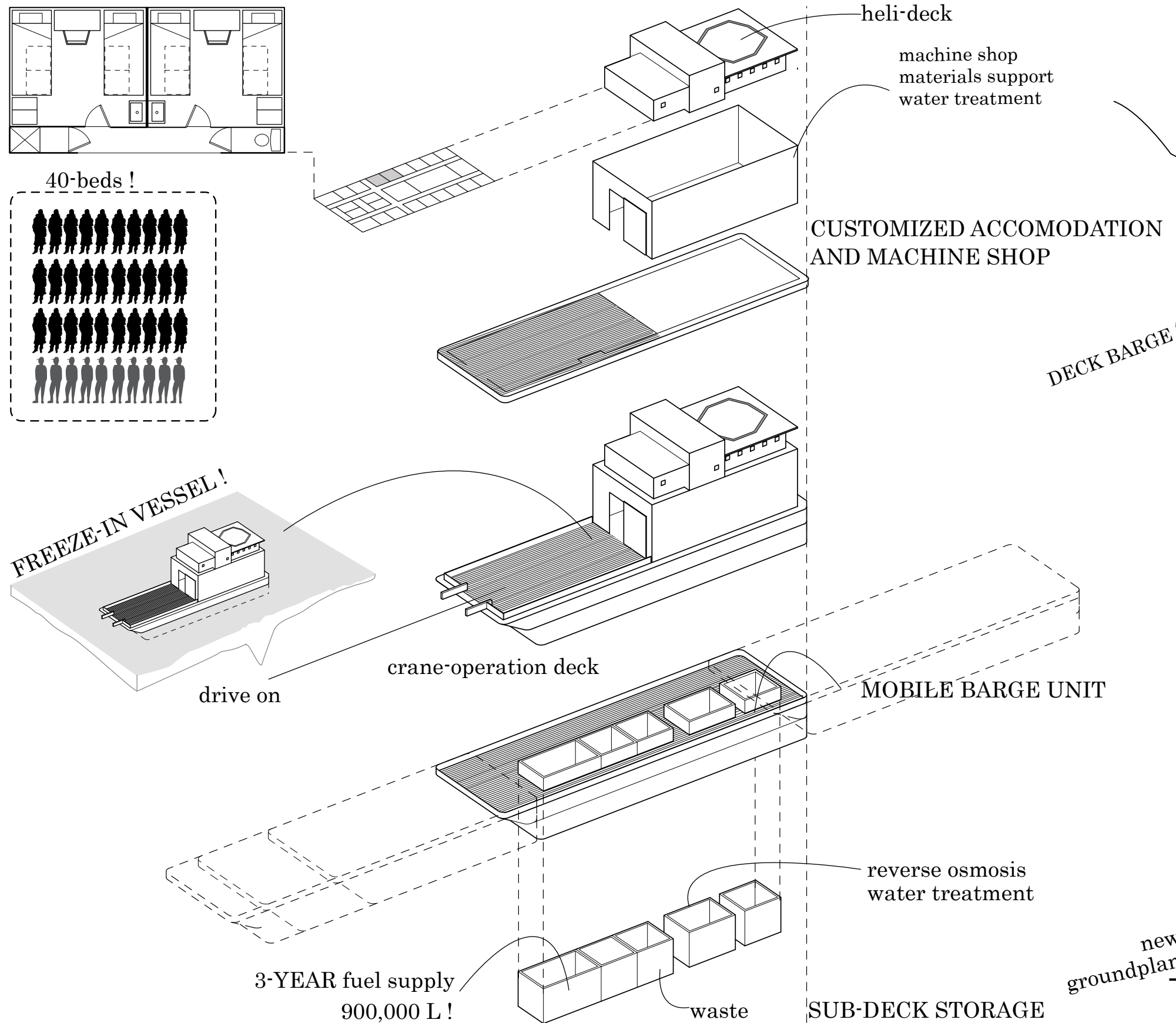
ON-DECK CONTAINER SHIPPING



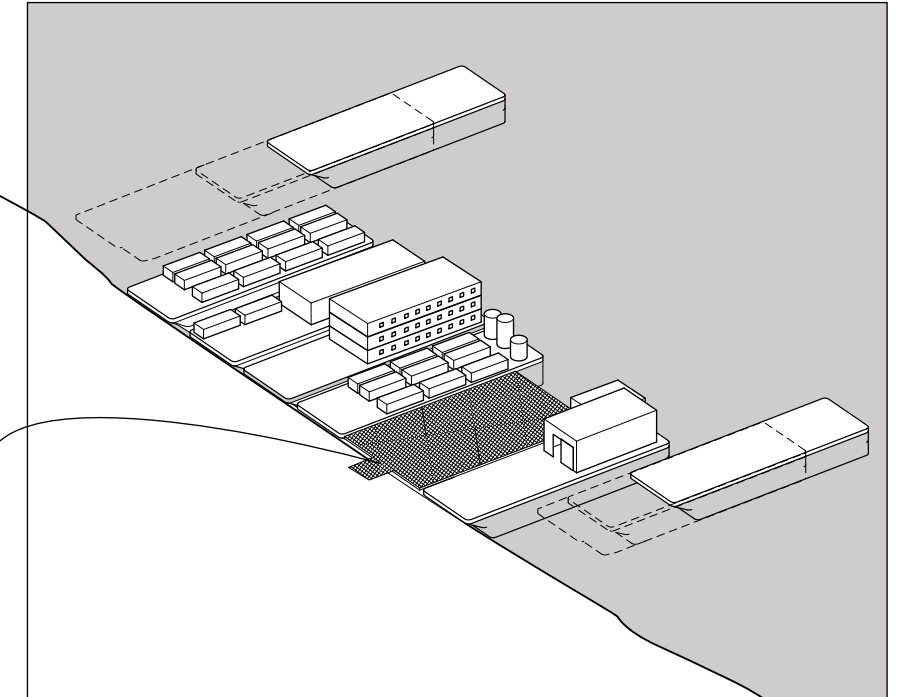
BARGE INTERIOR : FUEL STORAGE



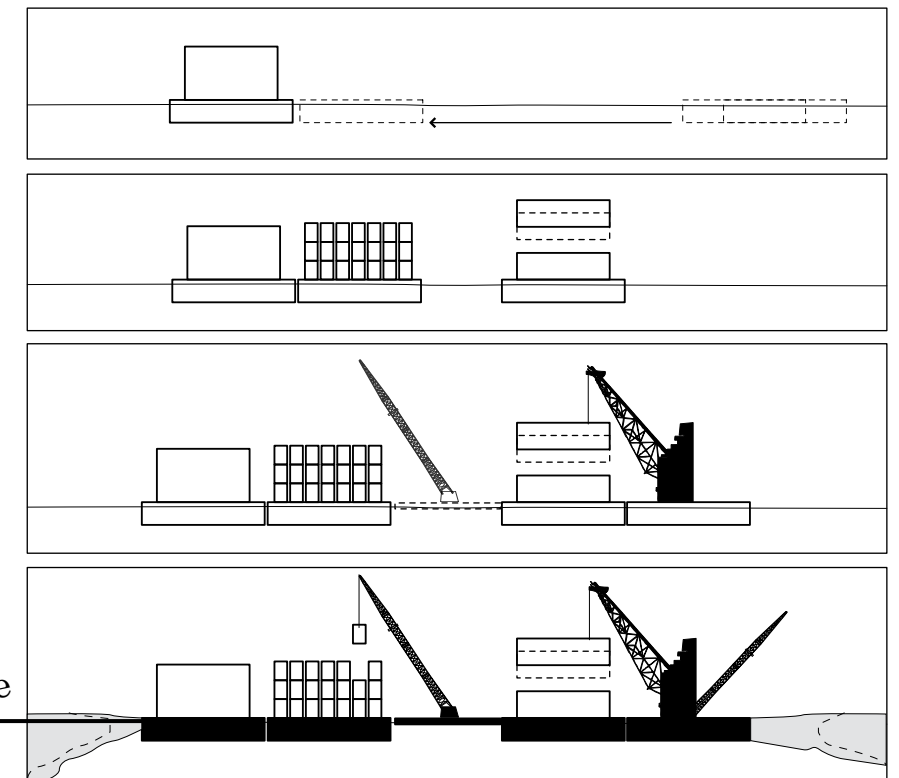




## MOBILE INFRASTRUCTURE : RETROFIT BARGE



## MOBILE URBANISM RESPONDS TO CHANGING LANDSCAPE



BACKHAUL SHIPMENTS ON RETURN TO DELTA, B.C.  
1 time / year

SPECIFICATIONS :

NT 12000 CONTAINER BARGE :  
Sea-going Vessel

CARGO:

new program with Hazco.  
discounted shipment rates to remove  
unwanted scrap metal, appliances,  
dangerous materials and recyclable  
goods in Arctic communities with a  
poor waste stream.

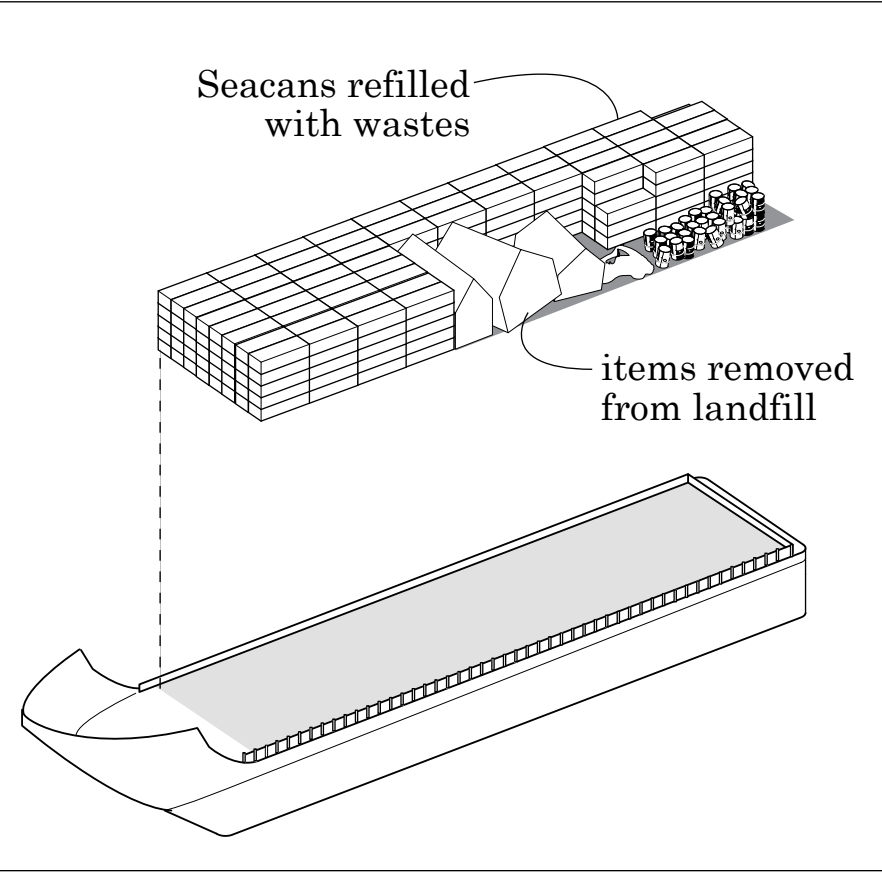
FINAL DESTINATION:

Hazco's waste management facility in  
Delta, B.C.

PRICE :

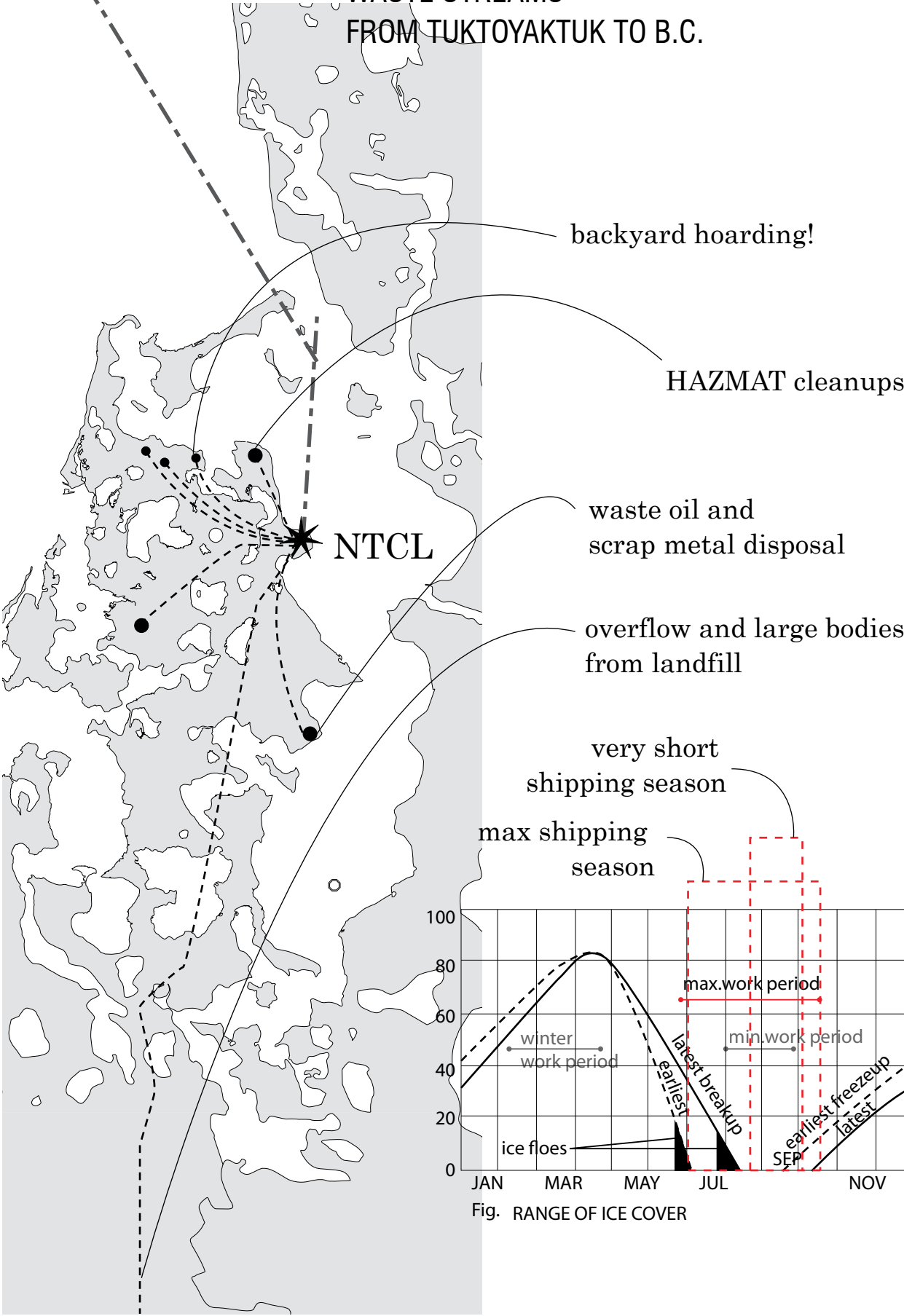
\$2,000-\$4,000 / container of scrap

\*environmental clean-up



ARCTIC LOGISTICS :

WASTE STREAMS  
FROM TUKTOYAKTUK TO B.C.





# SHIPMENTS FROM DELTA, B.C.

## SPECIFICATIONS :

NT 12000 CONTAINER BARGE : Sea-going Vessel

1 time / year

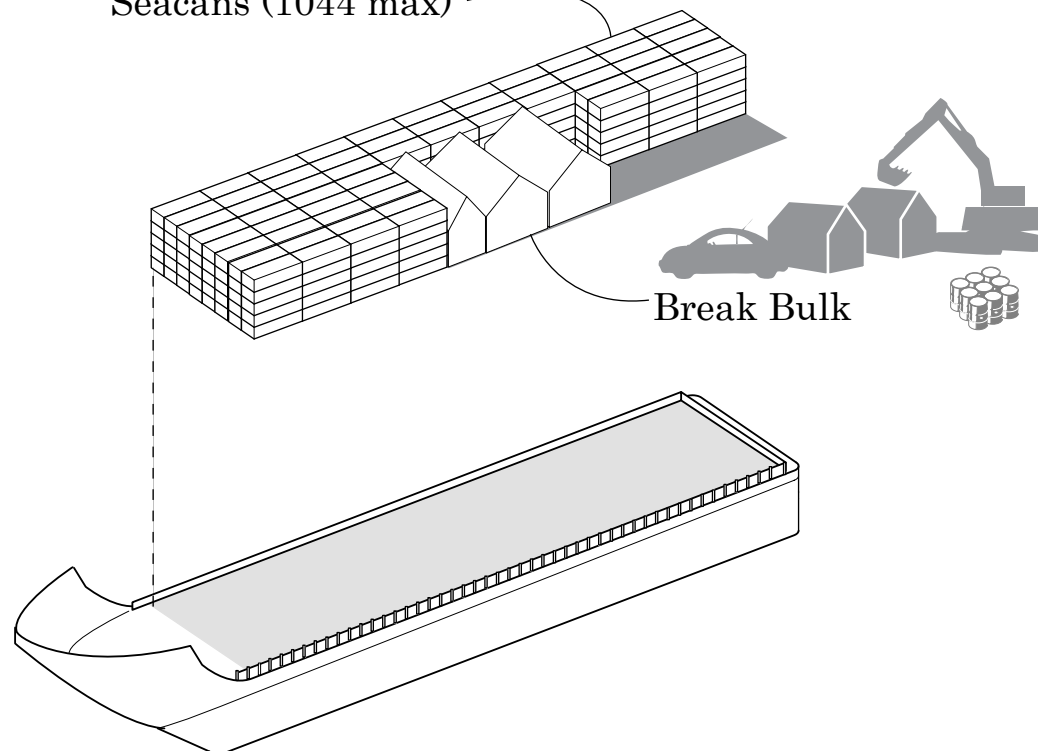
### CARGO:

large, PRE-FABRICATED  
pieces for onsite erection  
Both Container and Break  
Bulk cargo

Larger-capacity ships\*

\*Amount carried is con-  
strained by lack of deepsea  
unloading facilities

Seacans (1044 max)



length : 403' (120 m)

depth : 23' (7 m)

GROSS DECK AREA : 42,315 SQ FT. (4000 m<sup>2</sup>)

breadth: 105'  
(32 m)

**5.5 X AREA OF SMALL SERIES BARGE!**

## ARCTIC LOGISTICS :

MATERIAL SUPPLIES  
FROM VANCOUVER, B.C.

POSSIBLE DEEP-SEA PORT ?

no deepsea  
harbour entry !

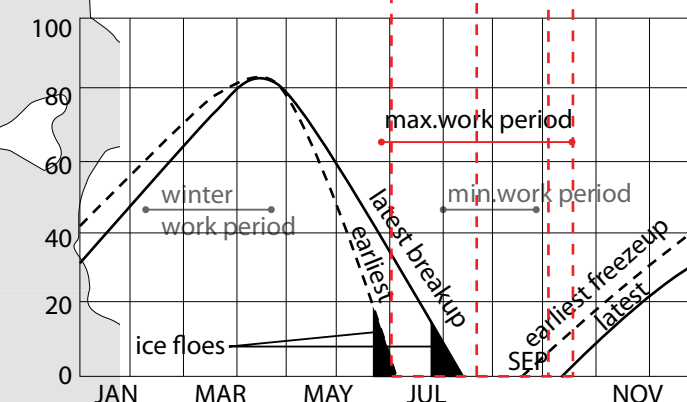
international port ?  
vessel must ground  
or dock itself

deepsea harbour  
is not accessible  
as a port

NTCL

very short  
shipping season

max shipping  
season



## ARCTIC LOGISTICS : MATERIAL SUPPLIES FROM HAY RIVER, N.W.T.

DEADWEIGHT CAPACITY : 830 TONS / 6100 BBL OIL

LENGTH : 160' (49m)

DEPTH : 9' 8" (3m)

LOAD DRAFT: 6' (2m)

24'

40'

40'

32'

24'

GROSS DECK AREA : 7673 SQ FT (713 m<sup>2</sup>)

BREADTH : 48'  
(15M)

### SHIPMENTS FROM HAY RIVER

#### SPECIFICATIONS :

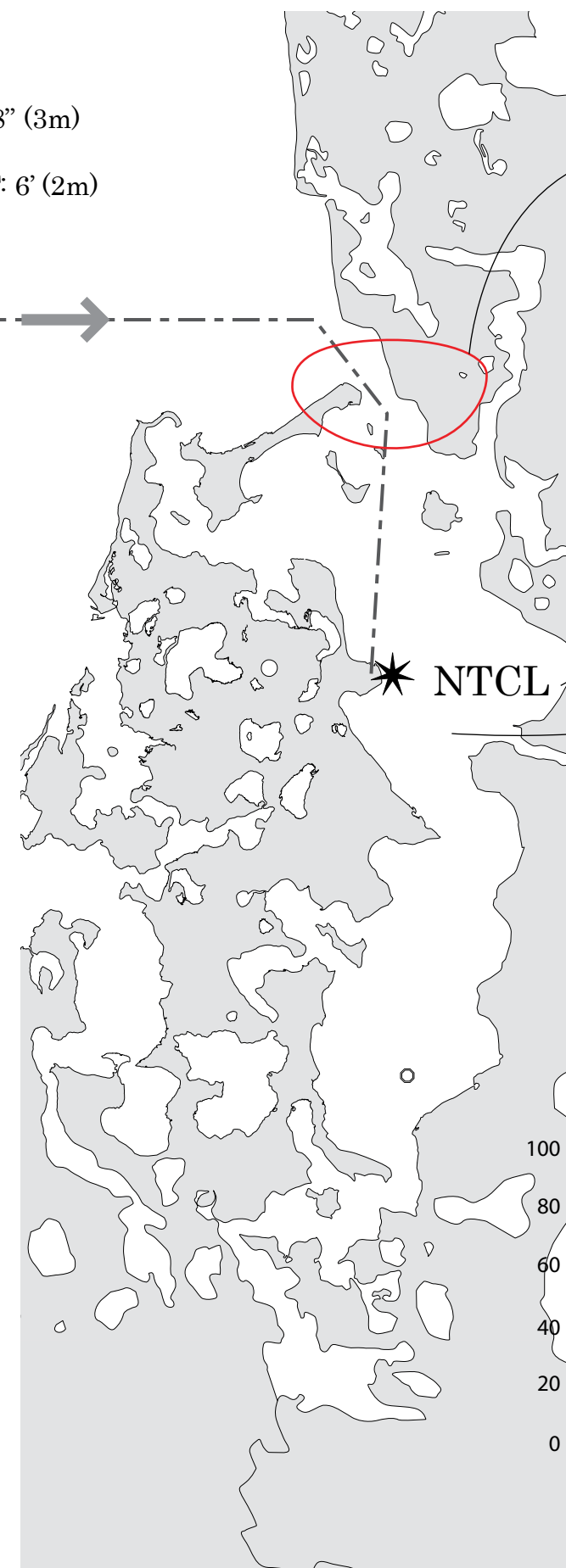
4 times / year

NTCL 800 SERIES BARGE : Small barge series vessels  
Shallow-water berths.

#### CARGO:

Small load cargo and disassembled, flat-packed items.  
Construction materials, non-perishables, goods and electronics  
ASSEMBLY of shipped pieces is required.

1,800 km  
via MacKenzie Rv.



no deepsea  
harbour entry !

international port ?

deepsea harbour  
is not accessible  
as a port

very short  
shipping season

max shipping  
season

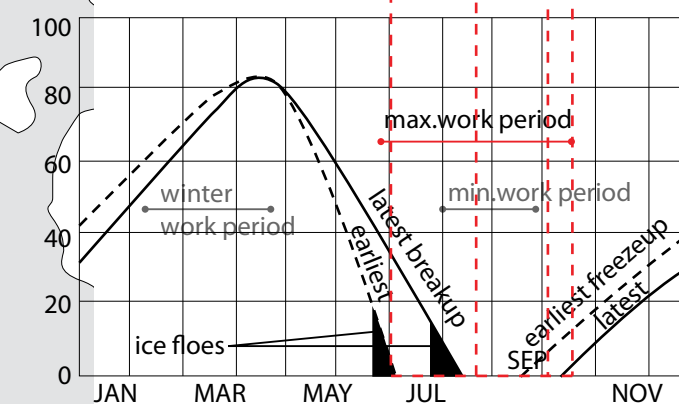
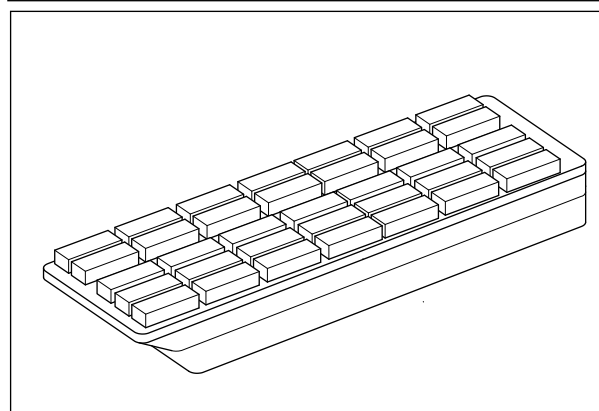
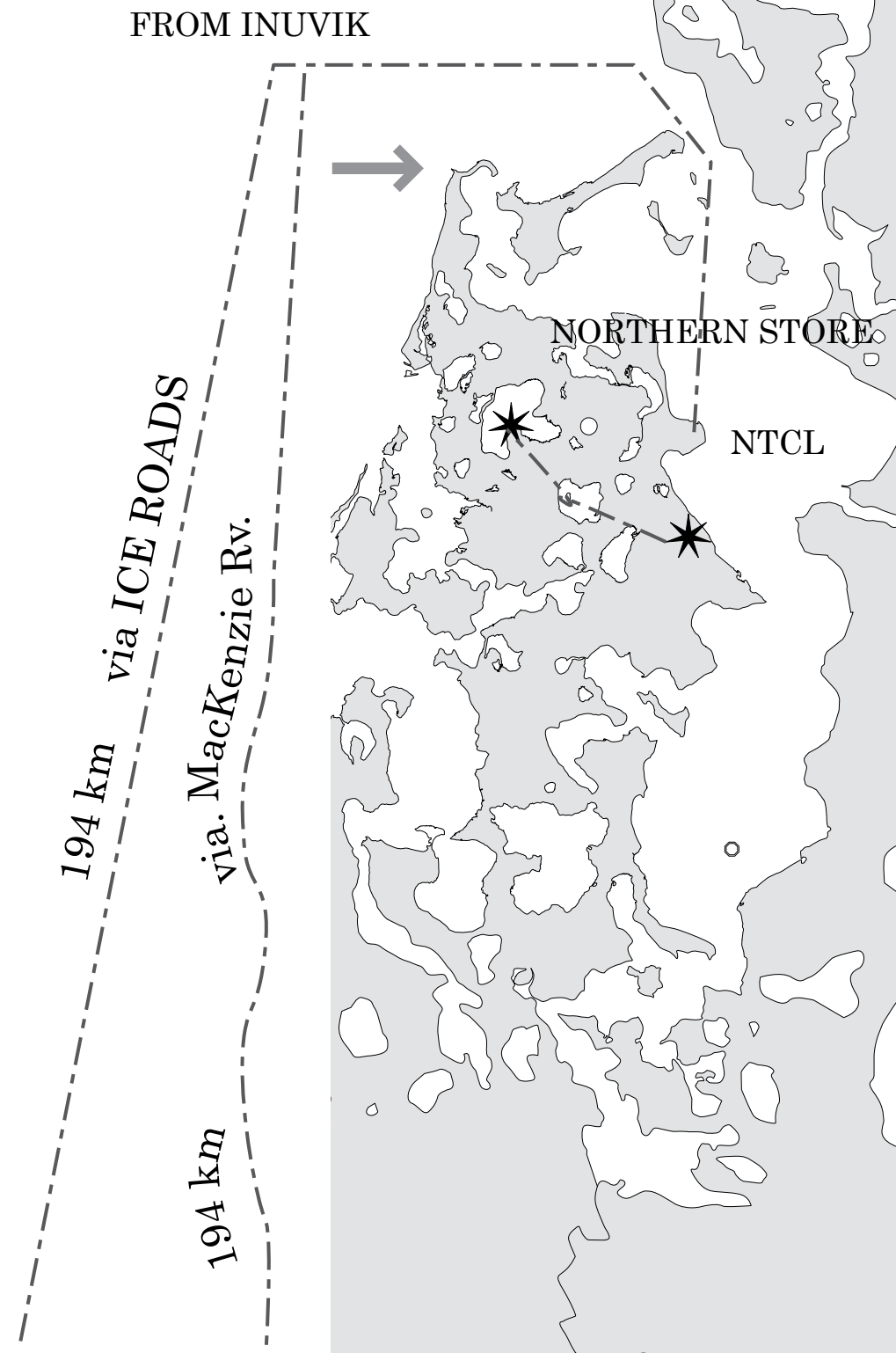


Fig. RANGE OF ICE COVER







## TUKTOYAKTUK FOOD DEFECIT

Food Mail Program by  
CANADA POST

“NUTRITION NORTH CANADA”

\$0.30 / kg perishable items

\$2.15 / kg non-perishables

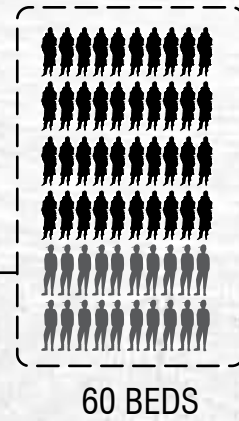
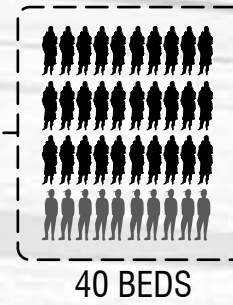
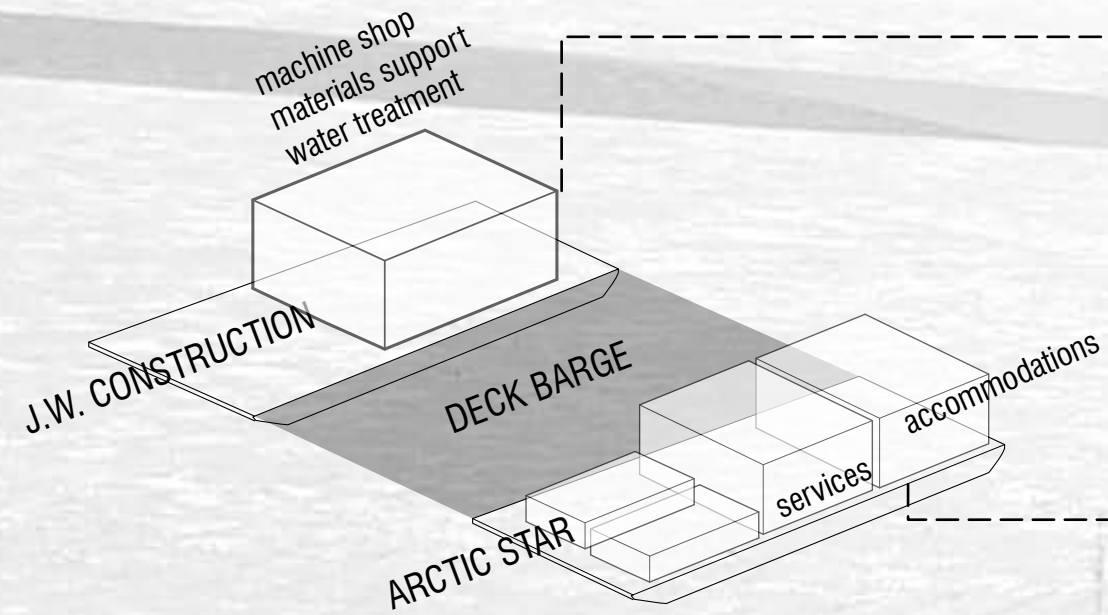
TUKTOYAKTUK STATS :

Avg Empl Income : \$28,077

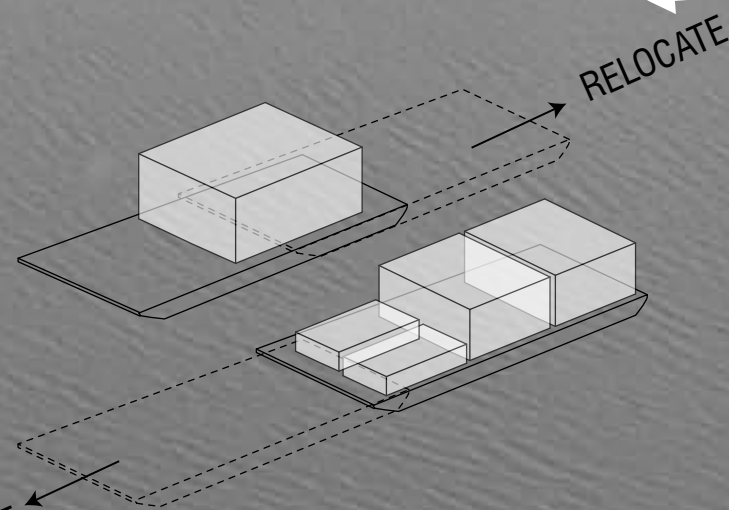
Homes where +50% meat  
consumed is “country food”: 63.3%  
(NWT : 28%)



## BARGE CAMPS : MOBILE OPERATIONS



CONSTRUCTED TEMPORARY EDGE

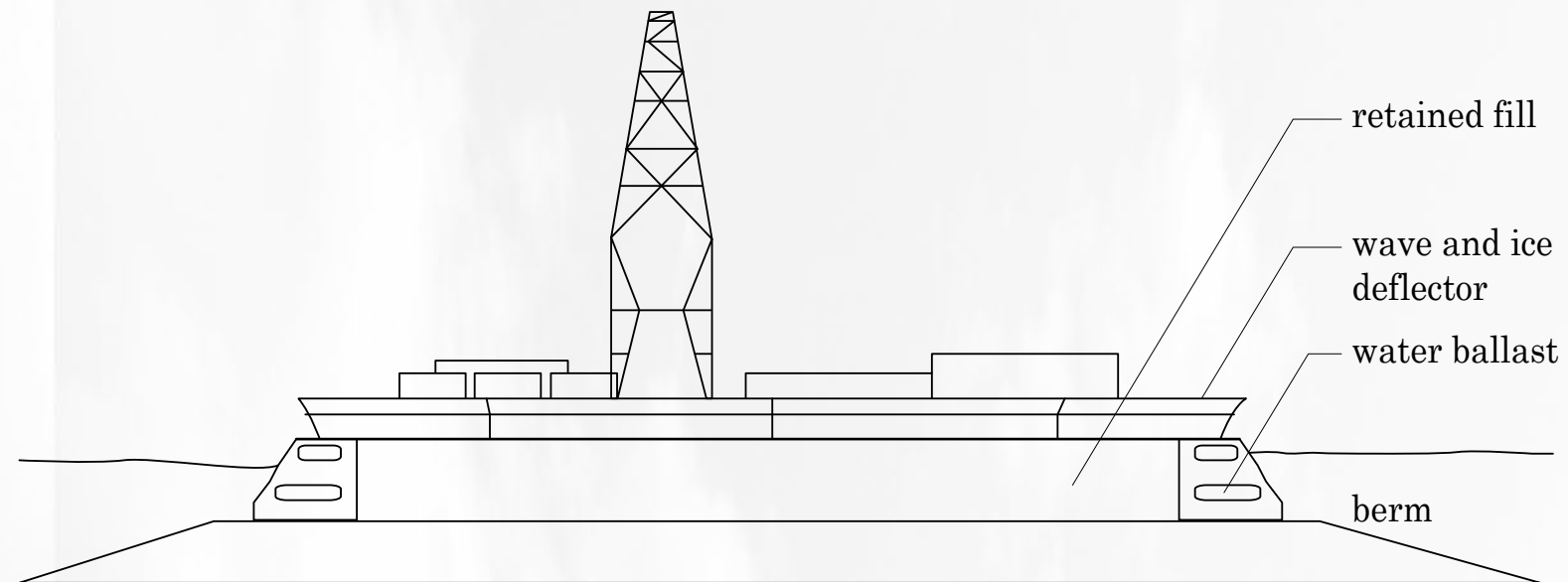


JOHN WURMLINGER SELF-CONTAINED WORK BARGE



ARCTIC STAR CAMP BARGE

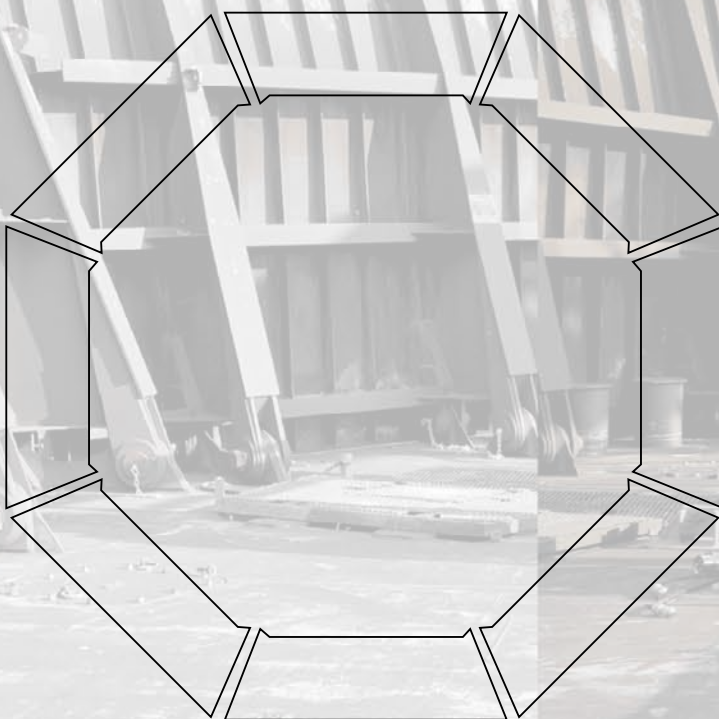




## STRESSED CRI (Caisson Retained Island)

DEVELOPED IN 1976-77 TO REDUCE DREDGED QUANTITIES over the previous constructed ISLANDS built 1982-83 eight caissons in a ring held together by two pre-stressed bands of steel wire cable octagon 118m across / 12m high / 30degree incline central core 92m filled with sand.

3 seasons in the Beaufort Sea through 1983-86



built to withstand extreme conditions of ice and waves

caisson reduces amount of fill to construct the island  
creates a container for island fill  
also creates "instant" protection against erosion  
CSA G40.21M Grade 350A steel

where in contact with ice impact or ambient air: Charpy-V Impact value of 27 joules and -50°C

MITRED ends of each caisson : vertical and horizontal shear keys prevent rotation  
MATING SURFACE : rubber bearing pads absorb compressive reaction when stressed due to movement  
380mm diameter pins through mating coupling heads  
tensioned steel cables allow caissons to withstand external loads and retained fill :  
16-76mm cables, breaking strength approx 420 tonnes/each.  
post-tensioned by 32 hydraulic jacks : strength and rigidity.  
Jacks: Eight 800 tonne jacks in every second caisson stress the cables.

inside each caisson:  
10 ballast tanks, two fuel tanks, machinery spaces and control room  
Fuel : 290,000 L/tank ; 4,600,000 L total.

BALLAST: piping between each tank and the sea controls the draft and the altitude of the CRI  
tanks: insulated with 100-150 mm polyurethane foam to absorb forces from ice in tanks.

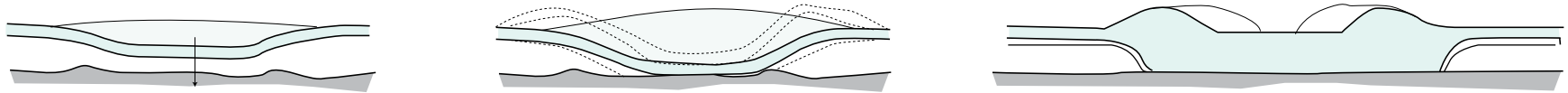
POSITIONING: using mooring lines connected to anchors with adjustable lengths.

HELIDECK: 22.9m squared for Sikorsky 5:61  
2 flare booms and steel support structures  
8 Beaufort, 12-person inflatable liferafts  
8 RFD Ltd. inflatable slide/raft evacuation slides w/ 25-person detachable rafts

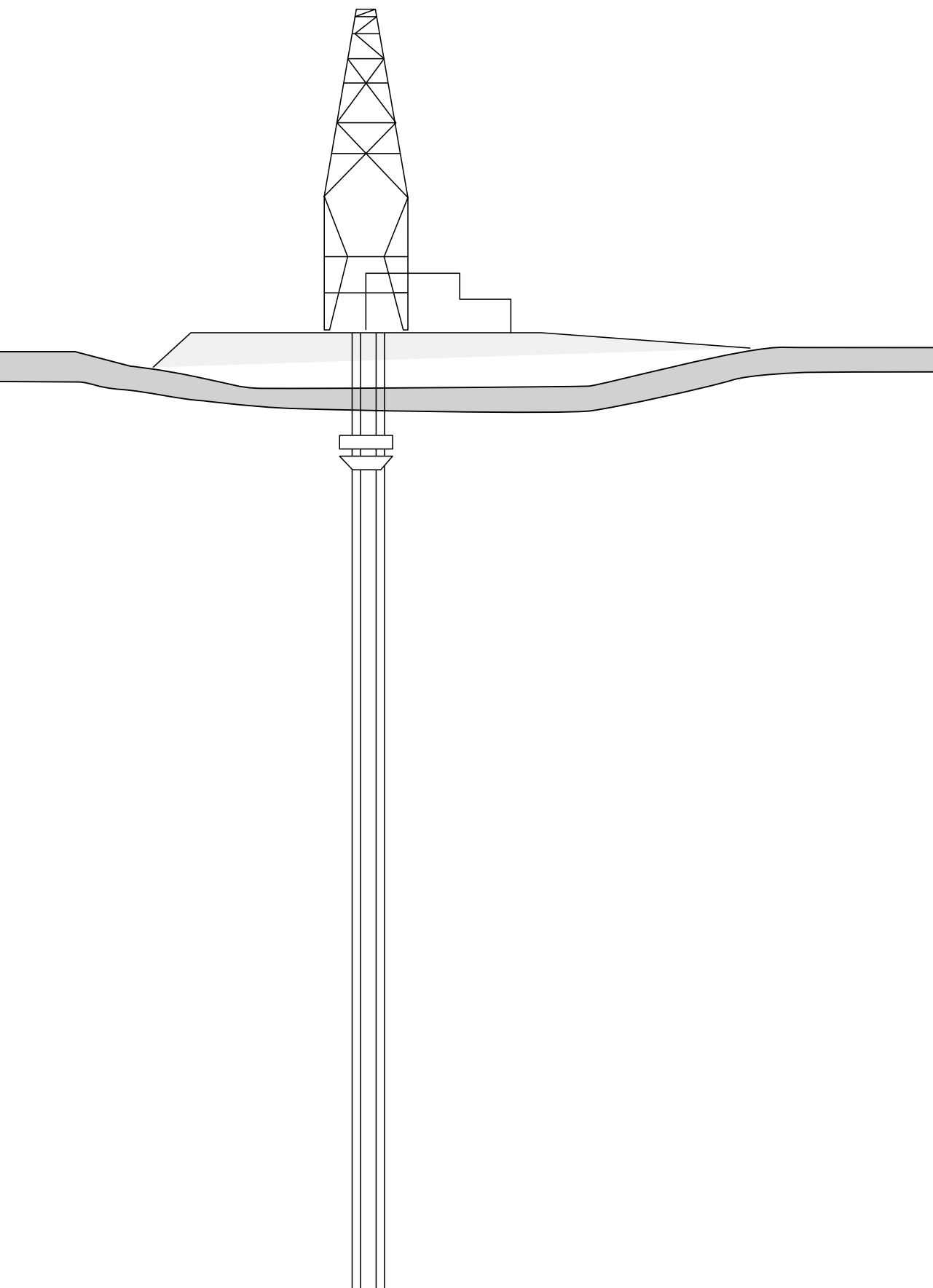
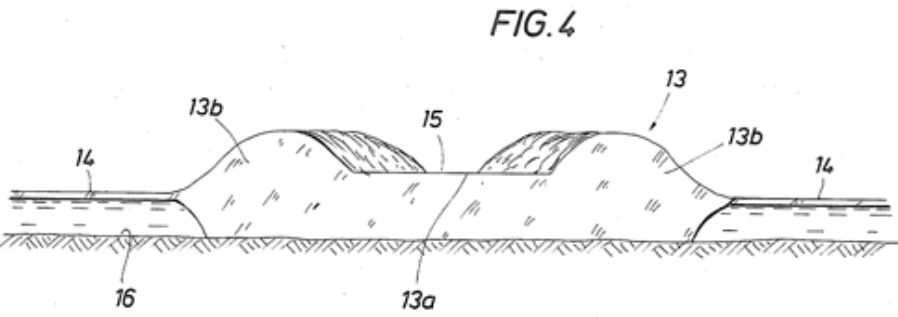
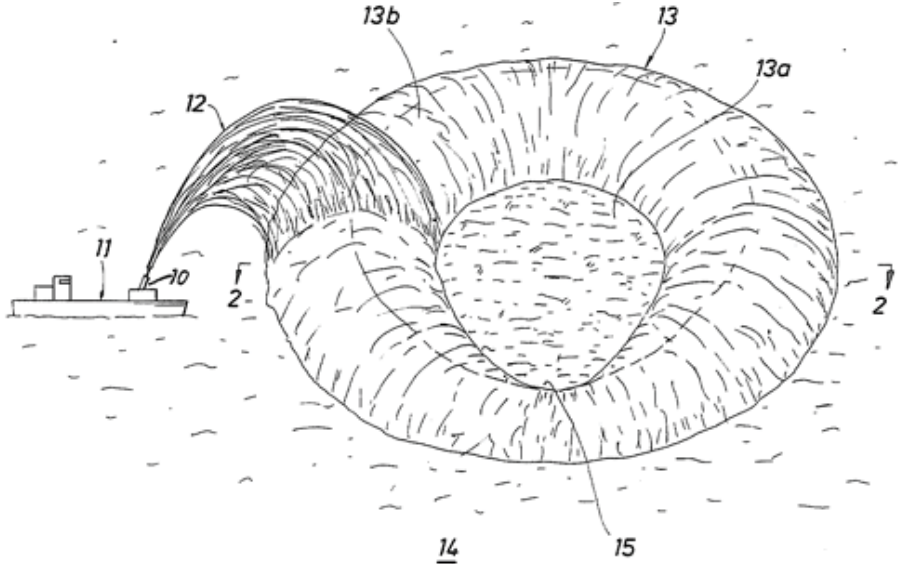
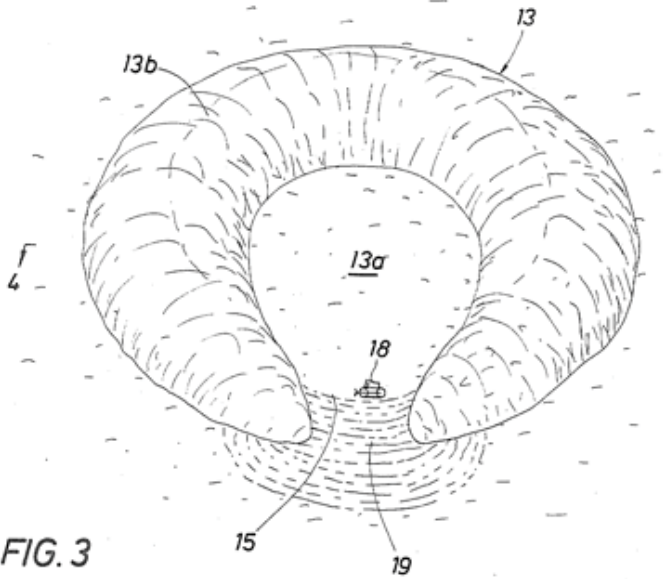
DEFLECTOR:  
front face angled at 60 degrees to encourage ice sheet failure by bending  
Deflector turns back overriding ice and wave run-up.

SAND FILL

ICE ISLAND  
the seasonally manufactured surface



U.S. Patent Oct. 13, 1987 Sheet 2 of 2 4,699,545





ARTIFICIAL ISLANDS

Constructing a new groundplane  
Permanent vs. seasonal / temporal  
Challenges and drawbacks

Shallow water drilling platforms in the Beaufort Sea

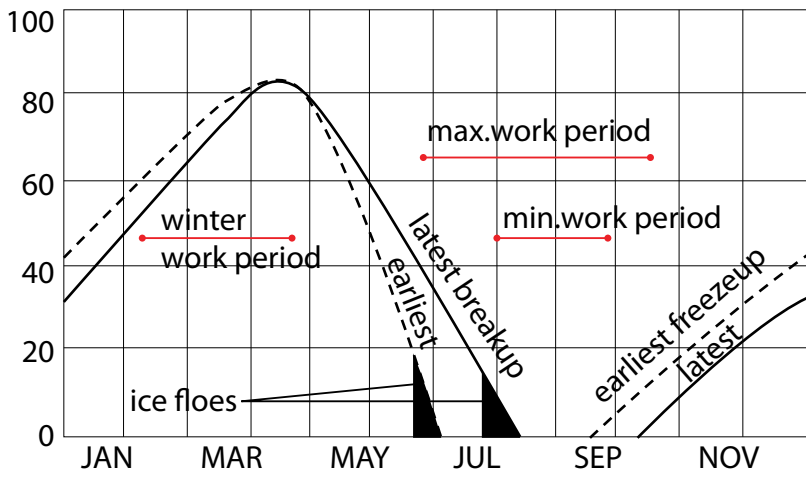
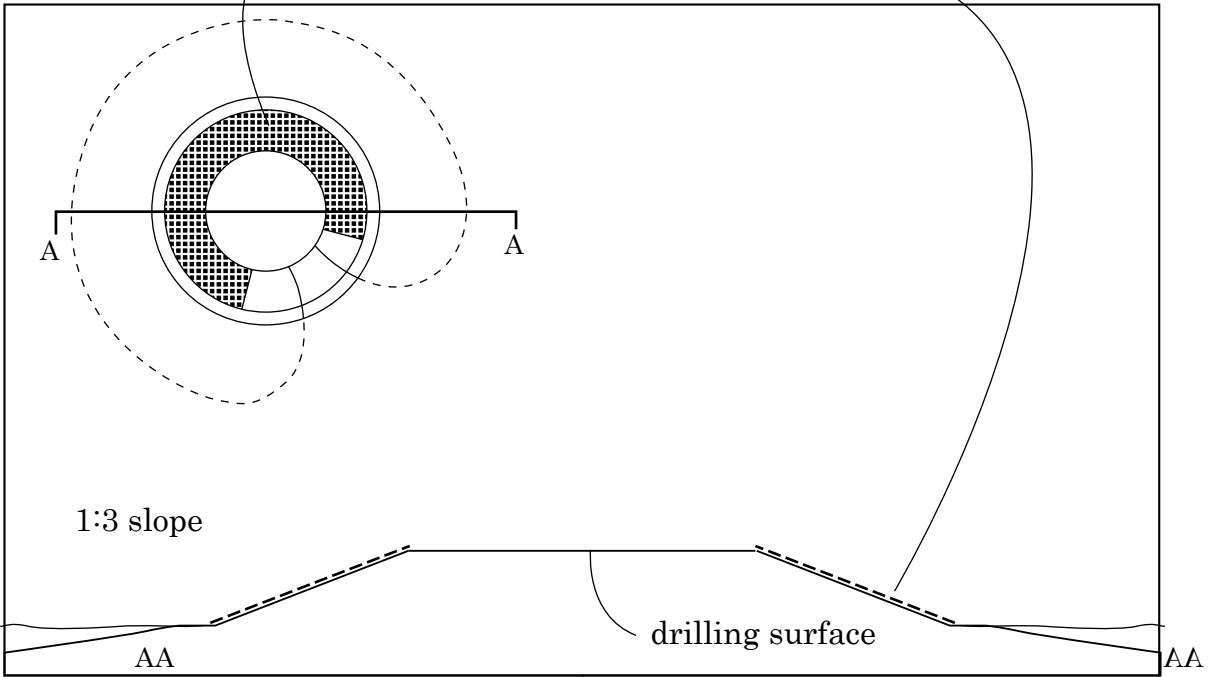
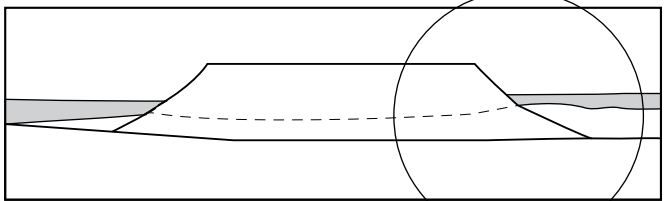
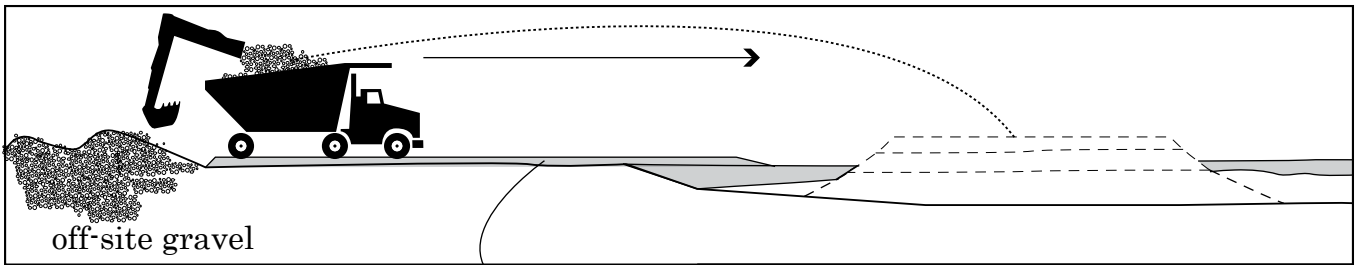
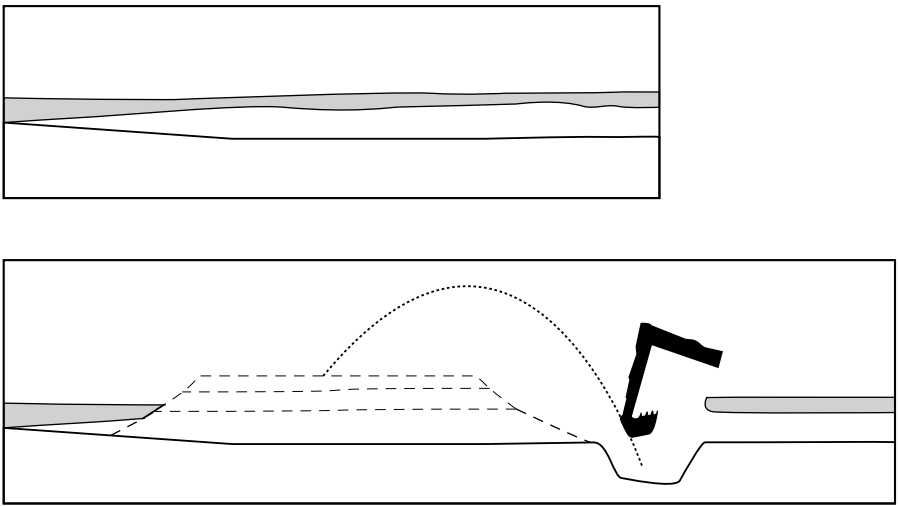
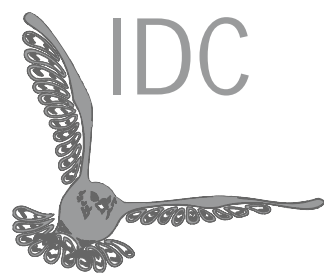


Fig. RANGE OF ICE COVER AS IT PRODUCES SEASONAL WORK PERIODS



SHALLOW WATER  
(up to 12 m)

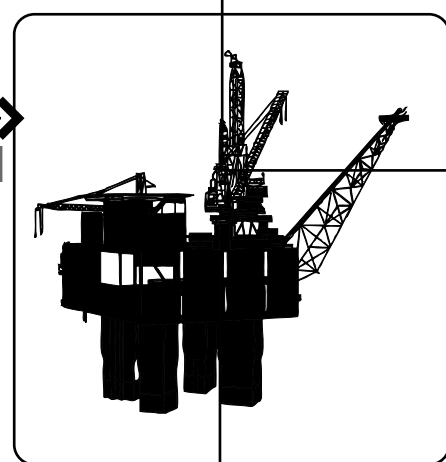
CONTINENTAL SHELF



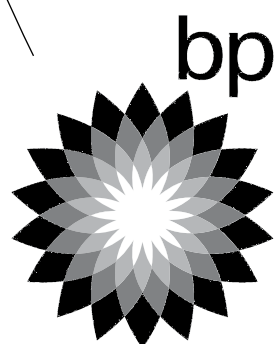
IDC

INUVIALUIT PEOPLE

**Transocean**  
RIG CONTRACTOR



future local  
ownership

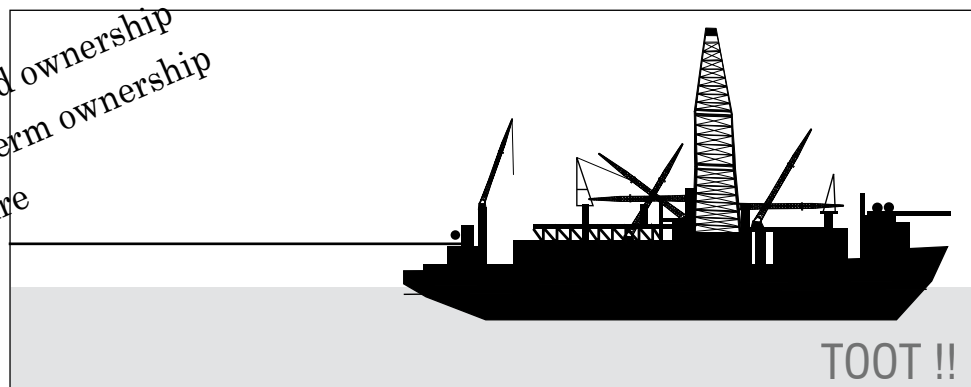


OIL COMPANY

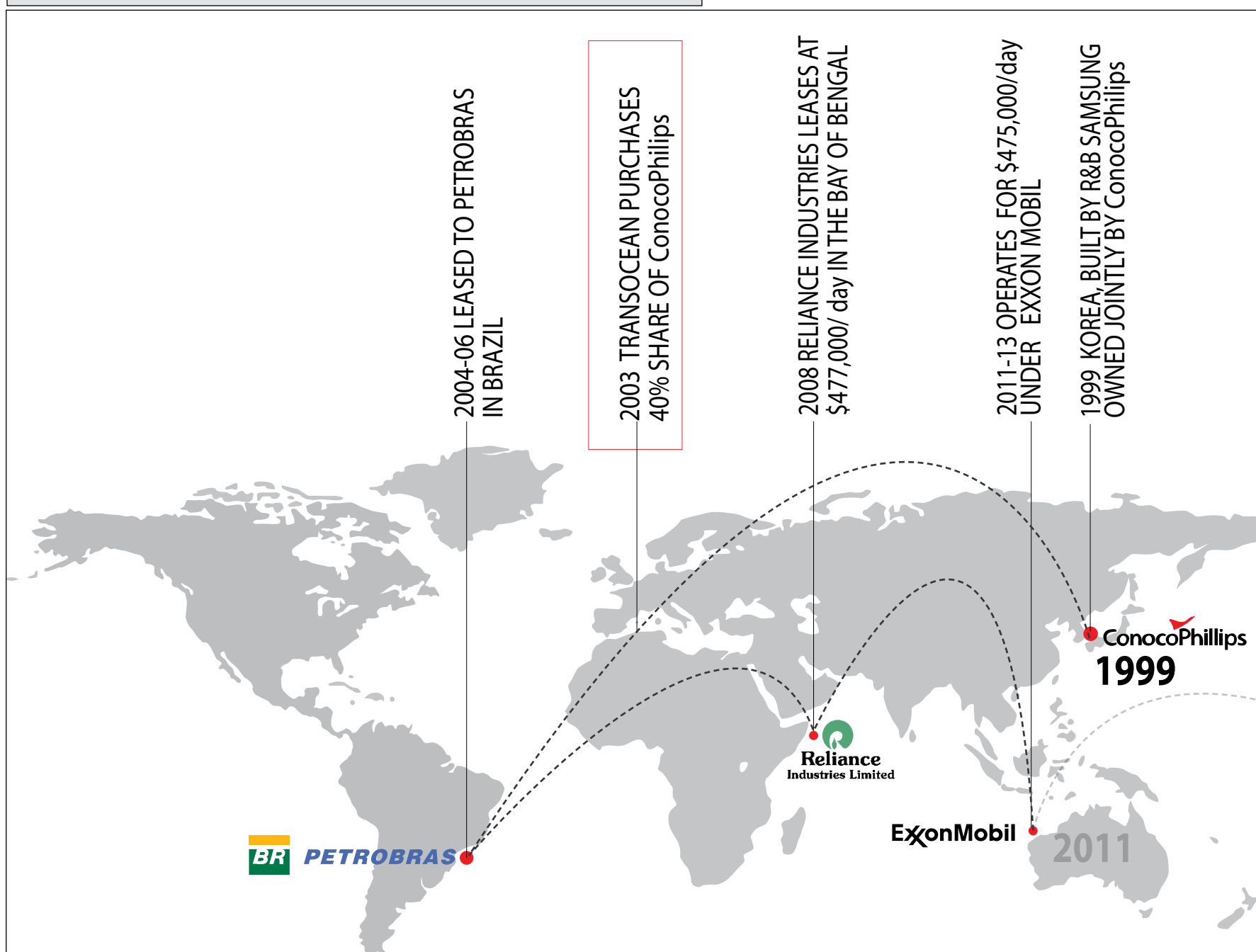


→ **ExxonMobil**

current contracted ownership  
mitigates long term ownership  
of infrastructure



TOOT !!

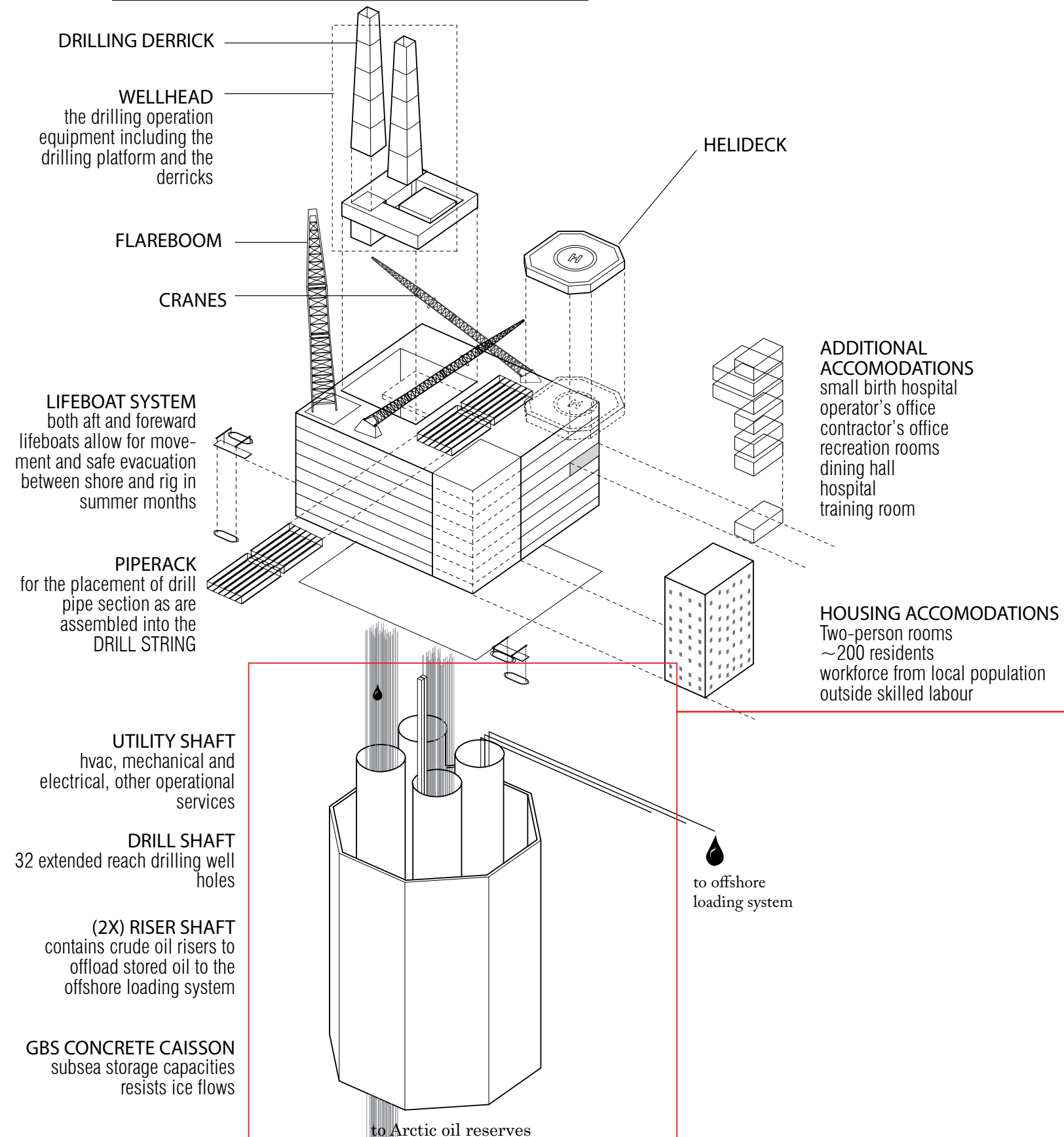


## MOBILE ASSETS :

Long life assets engage in the world market



## OOG RIGS: modular components



SUBSEA CAISSON  
DECOMMISSIONING by:

## HIBERNIA GRAVITY-BASED STRUCTURE CONCRETE CAISSON

Cone pedestal with Modular topsides

Consideration must be given to  
decommissioning and disposal

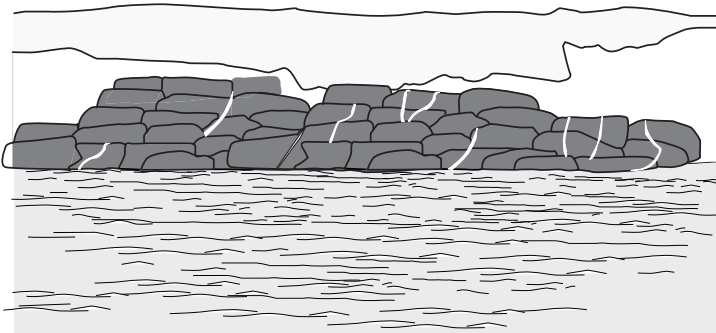
REMOVAL AND DISPOSAL

“RIGS TO REEFS” MARINE  
PARK PRESERVATION



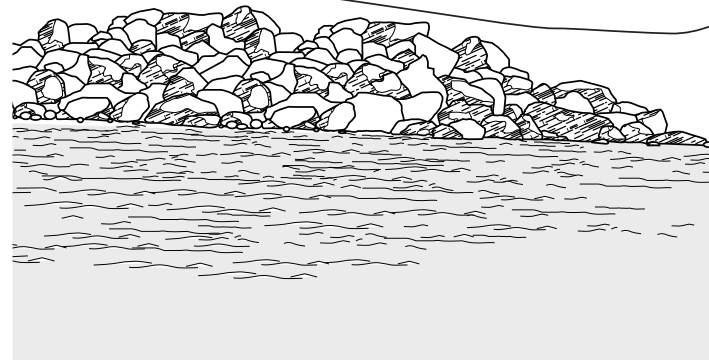
## COASTAL PROTECTION STRATEGIES

1987



**SANDBAG REVETMENT**

1998



**IMPORTED SHOT ROCK**

COASTAL PROTECTION UNIT

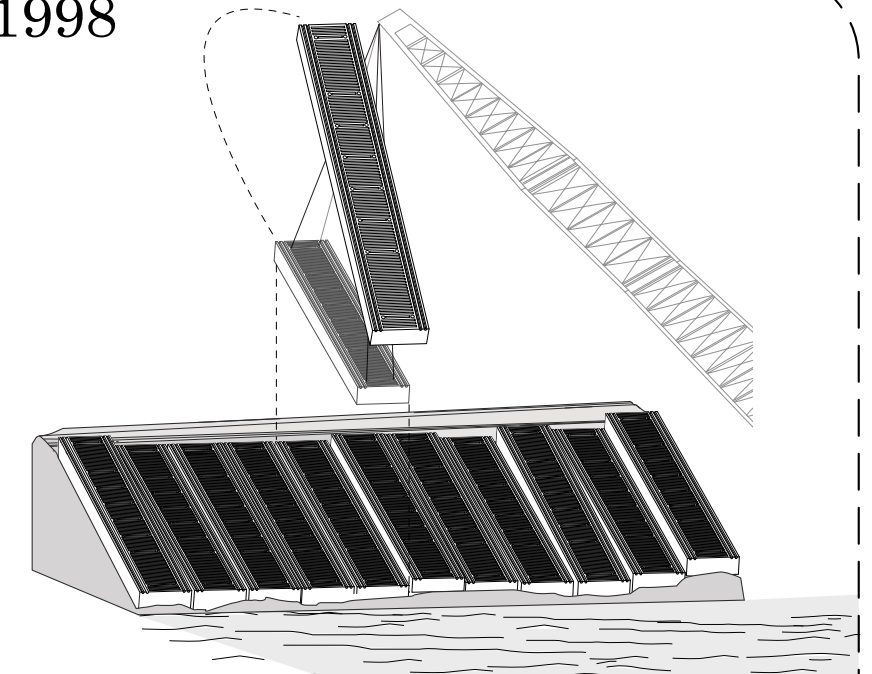
COMMISSION : TUKTOYAKTUK HAMLET

mitigate the erosion of coastlines  
demonstrate challenges of a changing community:  
seasonal and topographic

geotextile underlay  
toe protection of rip rap at the base of the concrete mats  
to prevent erosion of the coastline  
textile prevents washing away of underlaying gravel and  
sand.  
now tilting towards the sea.



1998



**40 CONCRETE MAT UNITS**

COASTAL PROTECTION UNIT

COMMISSION : Trillium Eng.



## 58 DEGREES NORTH PROJECT

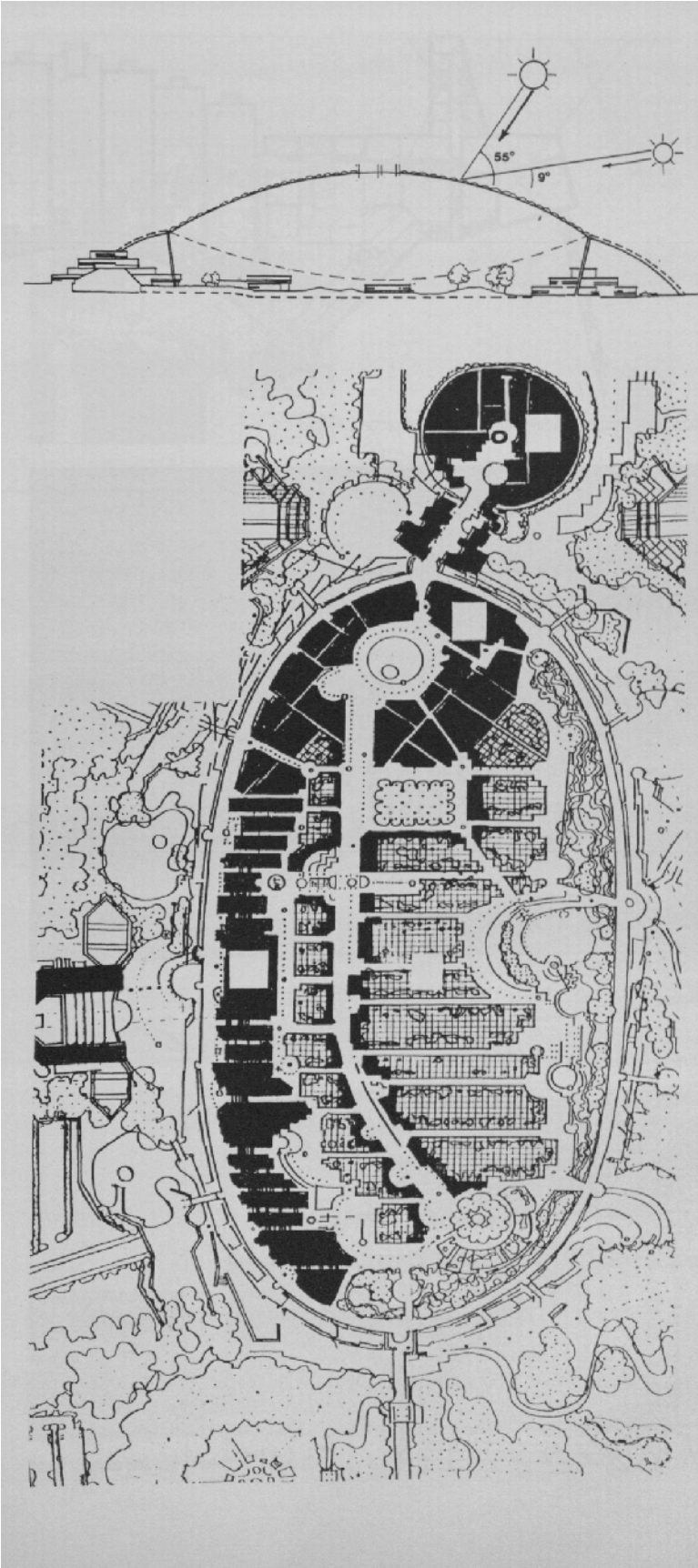
The climatic envelope

Frei Otto with Burro Happold and Bird Air

Shelter for a new mining community in Fort McMurray, Alberta for 45,000 employees  
1981

Air supported structural skin  
ETFE skin suitable for Northern extremes

Spanning structures for extreme climates







## SNOHVIT OIL FIELD\_ OFFSITE PREFABRICATION

ARCTIC CONDITIONS (Norway)  
LIMITED LOCAL INFRASTRUCTURE  
HUGE PROJECT SIZE

Offshore facilities prefabricated across Europe

Consolidated in Hammerfest and barged to  
construct Melkoya, ARTIFICIAL ISLAND

Limited imposition on the land

Strong economic development

Intense community cooperation and  
consideration to local cultures







## COMMUNITY FREEZER

Exemplifies community usage and management and infrastructure that responds to seasonal needs and fluctuations

Maximizing qualities of place: permafrost as Arctic infrastructure







# PLANNING DIRECTIVES

A Report to the Canadian Government  
on Strategizing the North





PLANNING DIRECTIVES:  
Strategizing Arctic  
Development

Designing the strategy for a new Arctic Urbanism responds to a past, present, and future occupation of the Northern territories. An understanding of the Inuvialuit people, their struggle to retain sovereignty over their land and resources is at the forefront of this design strategy. The accomodation of their needs, now and in the future, is the main directive for this work. Additionally, the Arctic climate demands that these infrastructures consider the nature of construction in a volatile climate. Moreso, the complexities of oil drilling operations, and the large, infrastructural demands of the industry as they forge into the Arctic frontier must be acknowledged as the primary economic opportunity that drives this work. Under the Canadian Government’s Northern Strategy, this project finds national imperative, as it seeks to operate within the needs of the industry, while establishing a stronghold of Arctic development that will provide a globally-recognized gateway to the Canadian North.

By analyzing Tuktoyaktuk as a study on such forms of oil-driven Arctic Urbanism, this thesis is able to strategize a future for a community in need. Through the investigation of existing conditions and failed operations on the land in Tuk, as well as an understanding of the needs, desires and fears of the Inuvialuit as they head into this phase of offshore drilling, the phased reconstruction of Tuktoyaktuk must deal with the following critical issues:

THE EDGE : The project will propose a defensive and adaptive edge strategy that is both occupiable and protective. It is this edge that will provide simultaneous access for the local community and the oil industry to the Tuktoyaktuk harbour. It will construct a new harbour for Tuk, in a LAYERED STRATEGY that creates a flexibility of occupaiton by its various users over time.

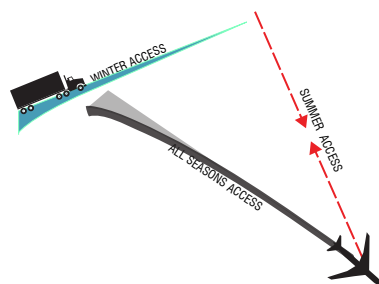
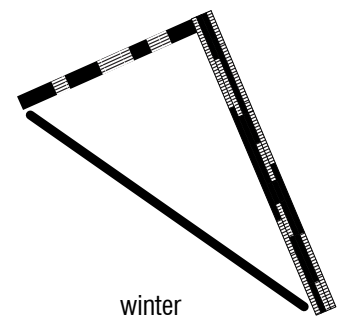
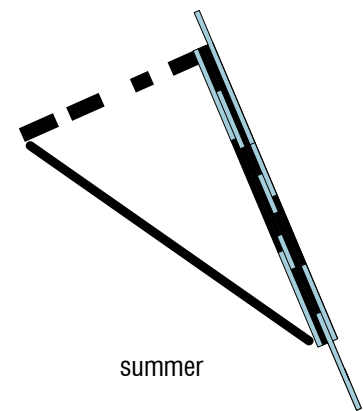
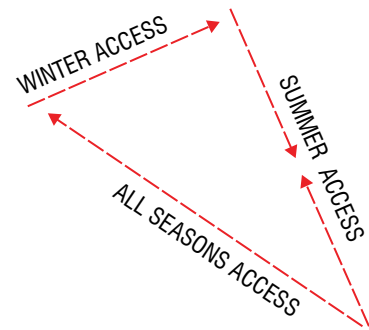
ACCESS : Disconnected geographically from the rest of Canada, the project must address access within the Community of Tuk. As areas of the landscape melt away, the infrastructural motives of the project should retain the critical connections between and within new areas of development and the traditional, eroding settlement.

GLOBAL NETWORK : Through the establishment of a successful marine infrastructure, the new harbour at Tuktoyaktuk will provide the community with the services required to function as a vital link within a global network of logistics, tourism and industrialization.

HOUSING : The project must address the need for housing for two population groups. Demands from both the local population and the transient workers of the oil industry must be provided for. A phased strategy that responds to shifting numbers of oil employees and possible increases in tourism and other transients, should be seen as an opportunity to conctruct individual housing units. The project will allow for the co-habitation of the local population with the industry workers in a layered strategy that reconsiders the notion of the Arctic dwelling and the “mancamp”.

HARVESTED LANDSCAPE : Issues of food scarcity and the loss of open land for traditional hunting and harvesting practices should be addressed. Along with the issues of subsistence, is also land remediation and the ability to generate a sustainable land-packing strategy with which to deal with industrial wastes in a safe and constructive manner.

Along with these strategies and critical issues, are the multiple layers upon which this thesis is built. As planning strategies and components of this Arctic Urbanism, these components will be illustrated and described in the design drawings on the following pages.



## DEVELOPING THE HARBOUR: THE FUTURE MARINE INFRASTRUCTURE OF TUK

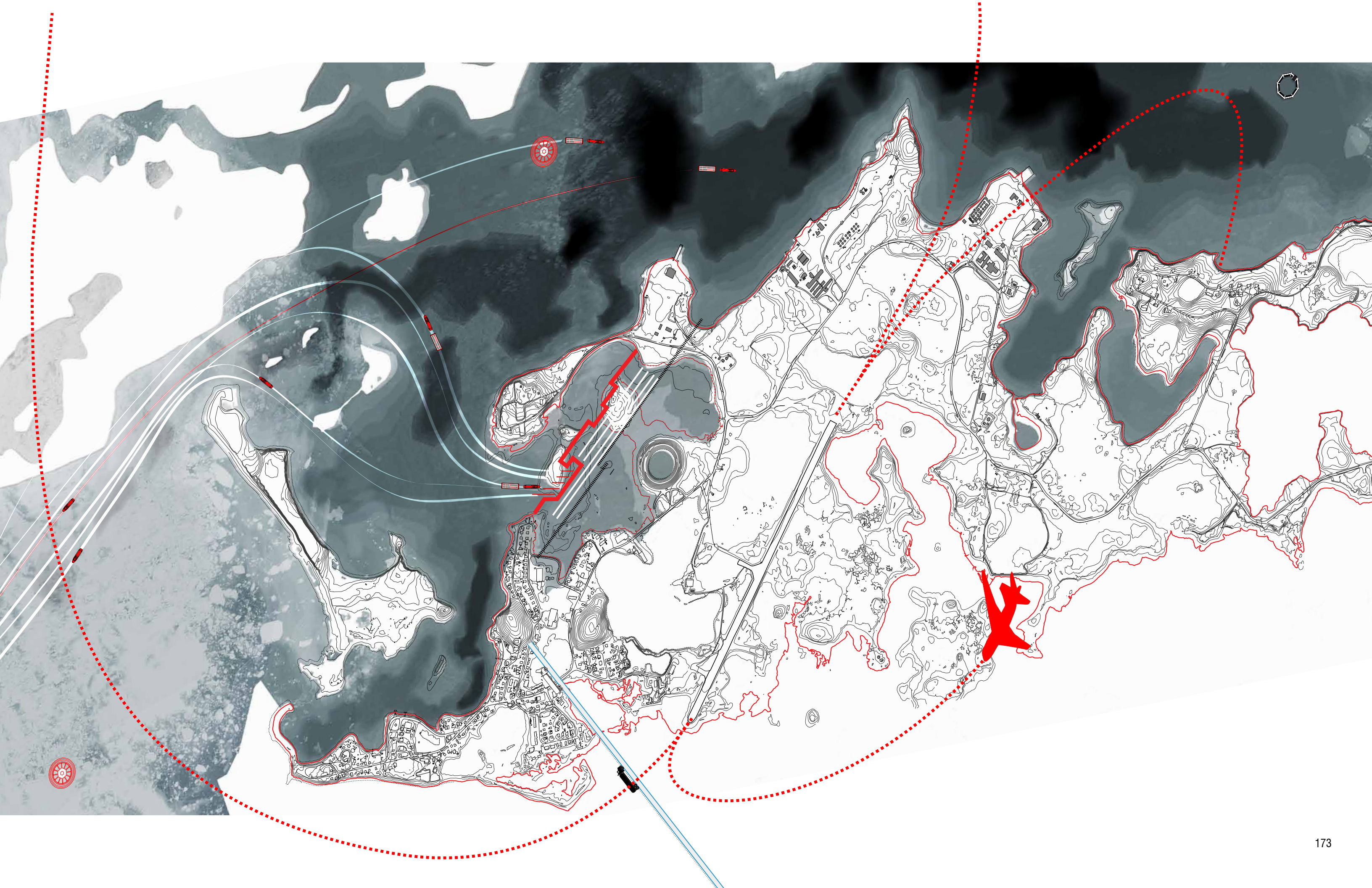
The world economy relies on the offshore resources of the Arctic. A successful extraction process must be supported by the production and transportation networks that make the operations profitable. It has been proven that air transportation is ineffective and unprofitable for mineral payloads. As well, relying on the winter access of the ice roads would only afford a brief period of time when oil could be transported south, overland, and the conditions on this ever-thawing ground plane prove to be unstable and dangerous for oil transport. The proceedings of the Mackenzie Gas Pipeline have not yet guaranteed this overland transport infrastructure this high North, and even if the project were to go forward, there are no plans to take it as far as Tuktoyaktuk. In this way, the increasing of marine transport infrastructure to support offshore drilling is gaining significant importance in Tuk.

The urbanization of Tuktoyaktuk will see to the strengthening and co-operation of existing infrastructures and logistics. Through increased marine capabilities, the operation of Tuk as a seasonal harbour will allow it to function more successfully as a gateway to the North. Upon the retreat of the oil industry, the operations of the harbour will offer a flexibility of scenarios for urbanization itself and will complete the seasonal access to the community.

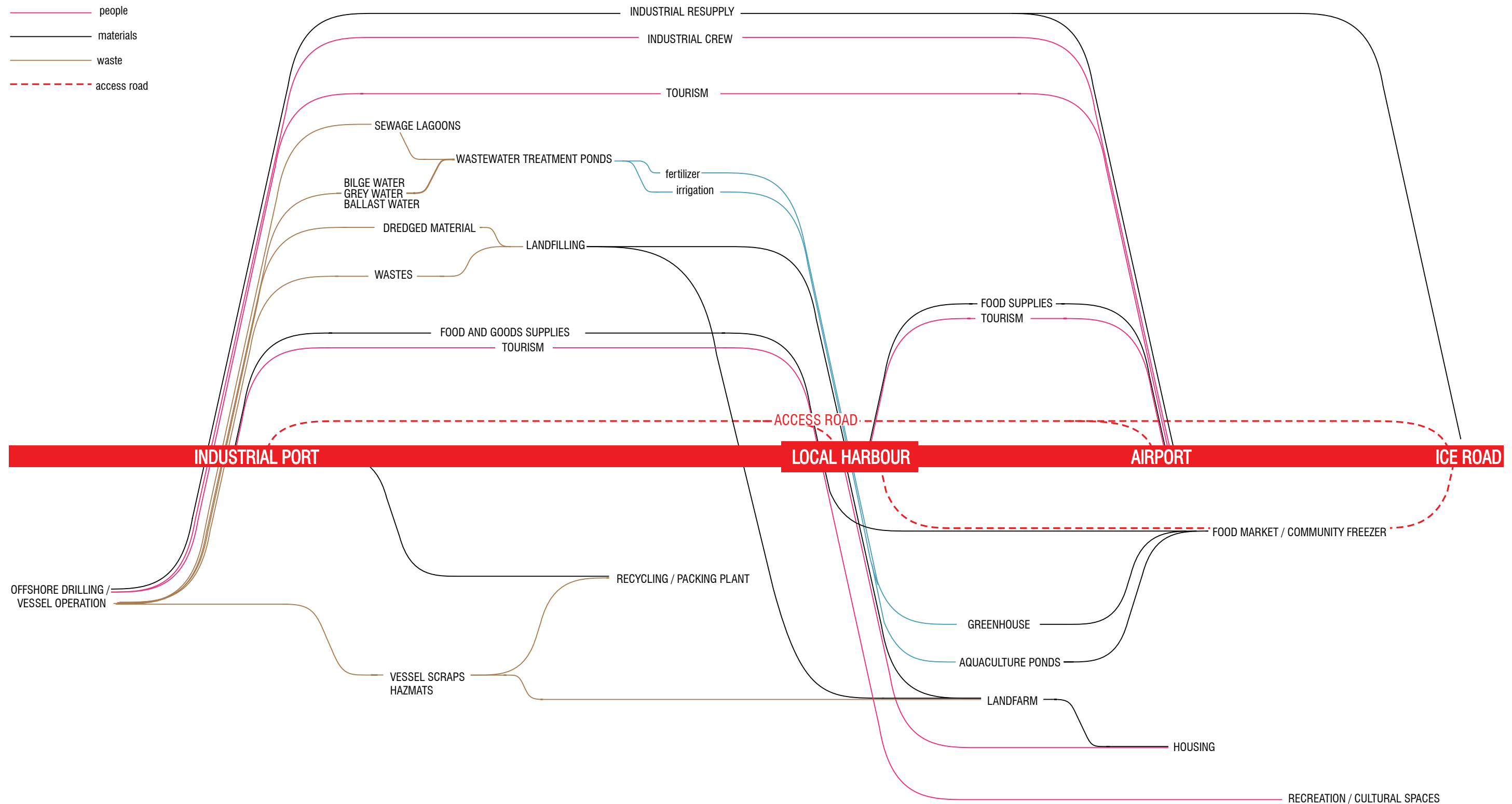
The harbour will change and evolve with the community itself, as the post-oil economy evolves, so too will Tuk transform into a distribution and production hub for the Canadian Arctic. Acts of site remediation, vessel decommissioning and recycling, shipping, and food production and distribution will all be able to thrive and activate Tuk as a new and strengthened economy. Utilizing the infrastructures set up during the oil operations, the community lives on while the figure of the groundplane around it, and the operations upon this groundplane change.

What is constant, is self-sufficiency, connectivity, and growth.



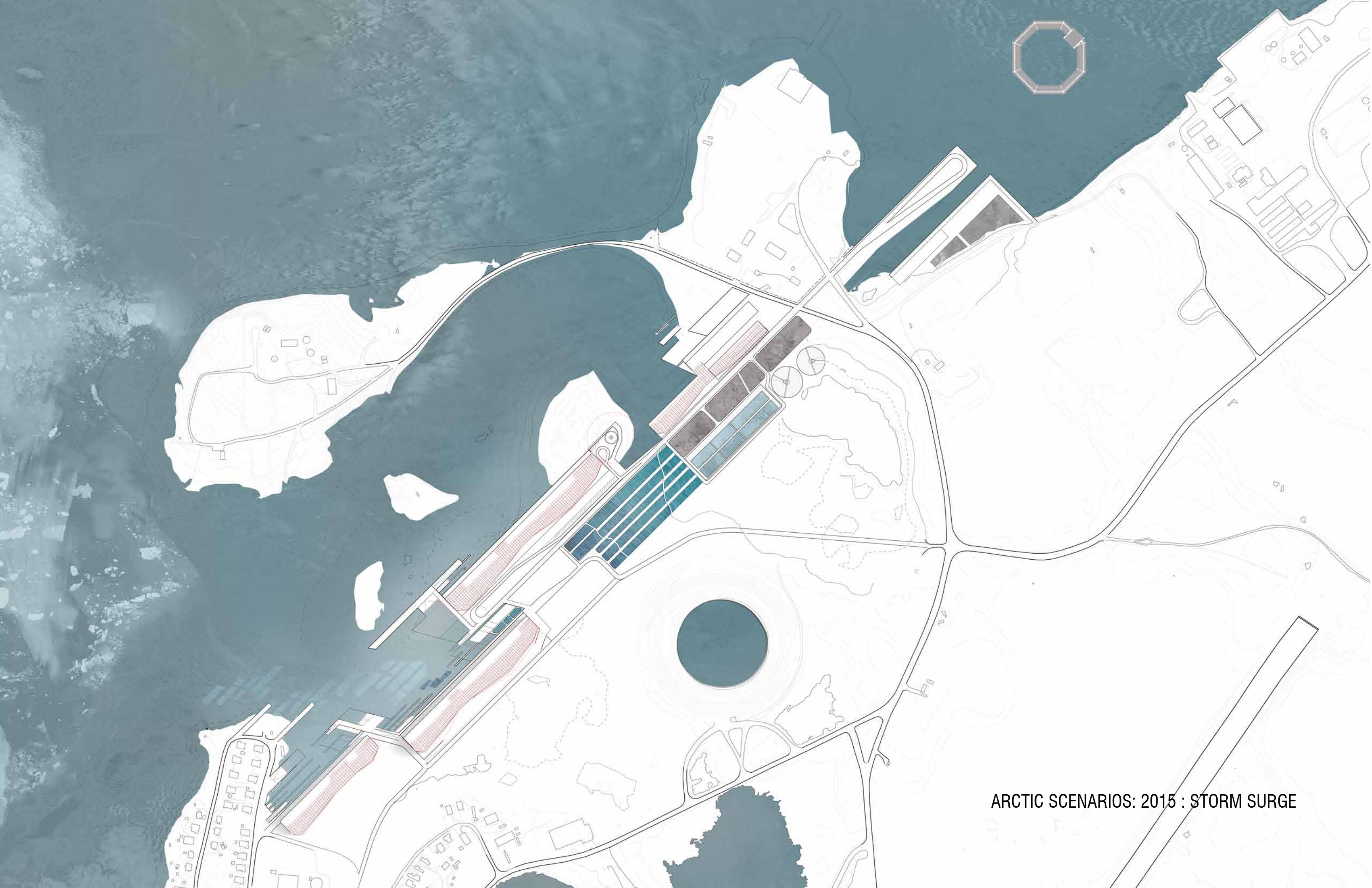






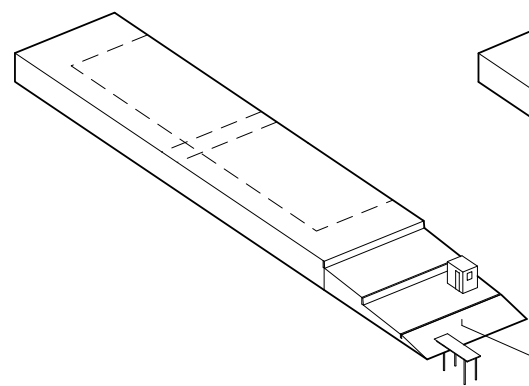
NETWORKED FLOWS AND LOGISTICS



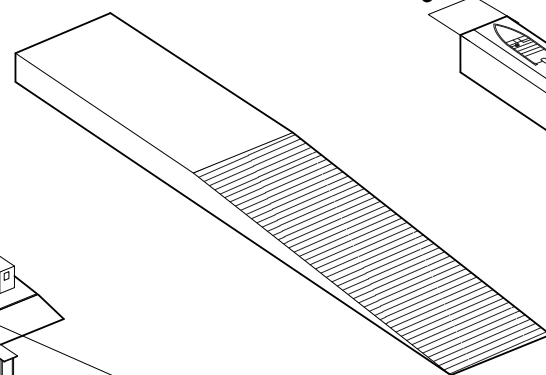


ARCTIC SCENARIOS: 2015 : STORM SURGE

deep steps

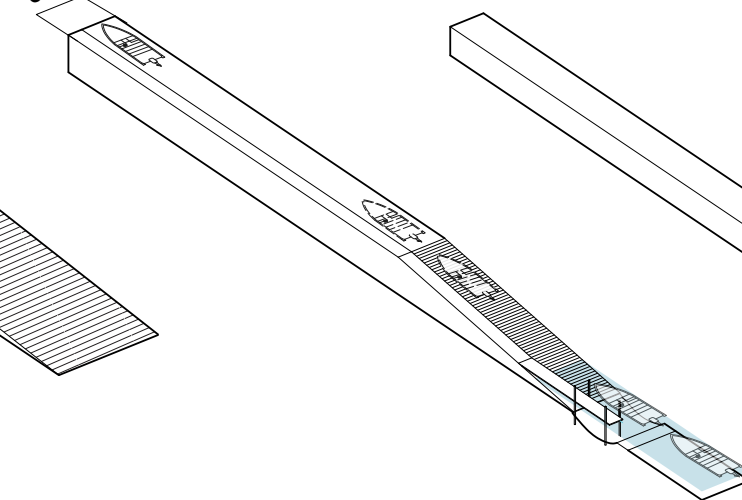


gradual rise

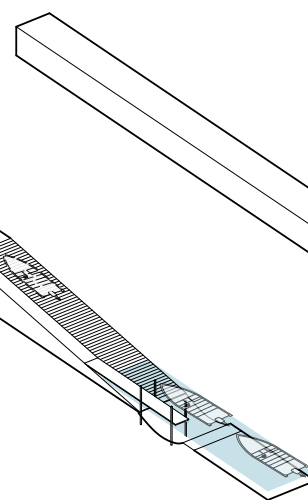


fishing boat launch

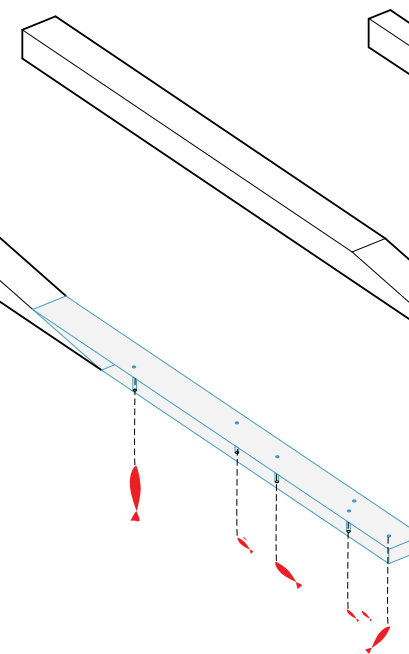
6 m



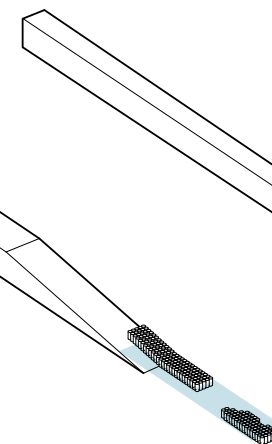
ice fishing strip



floating edge



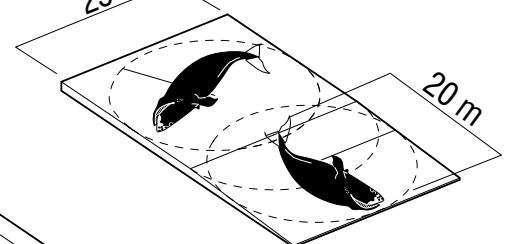
reinforced slope



whale dock

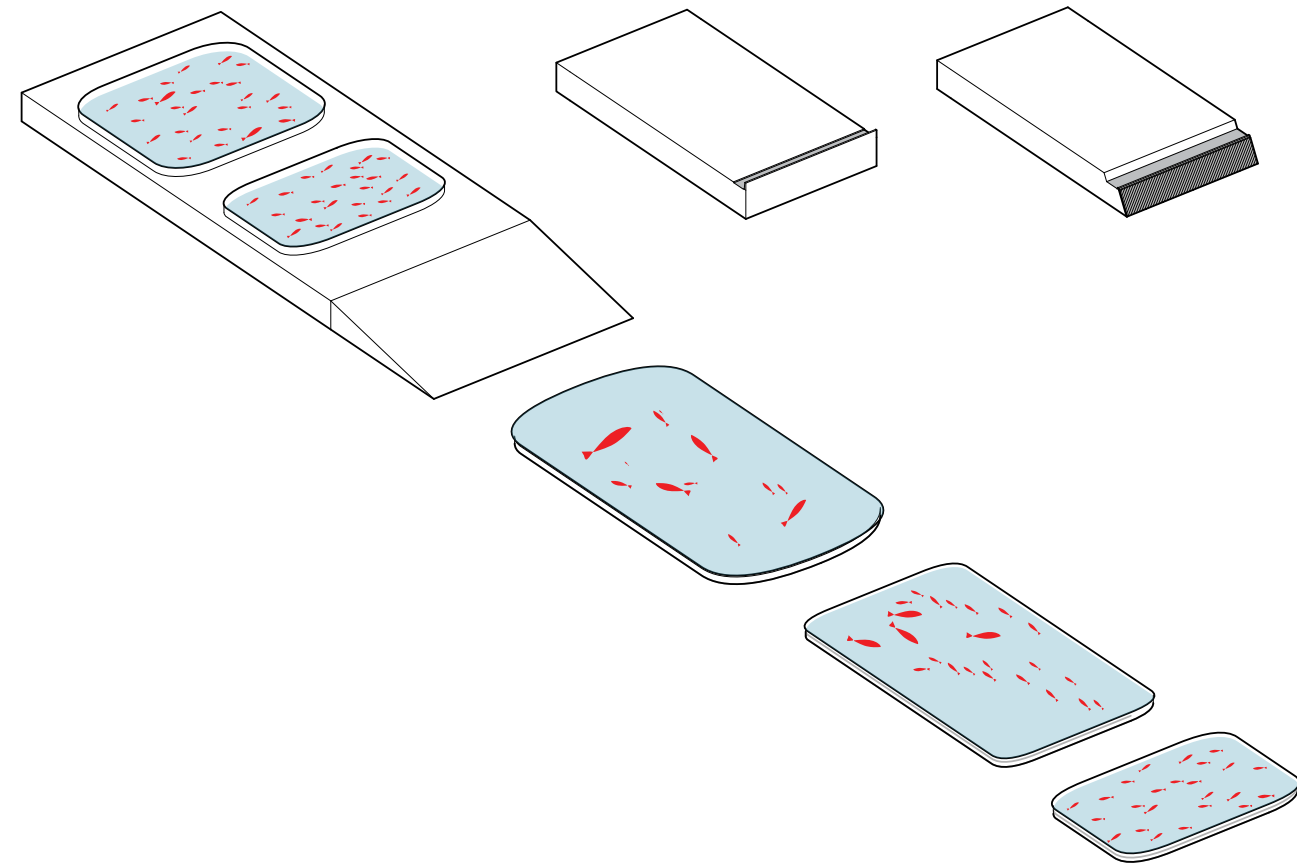
25 m

20 m

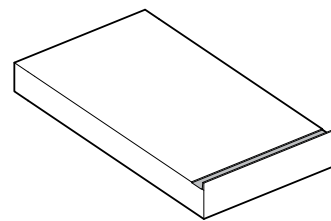




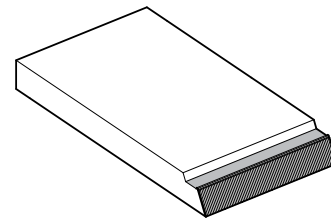
char farm



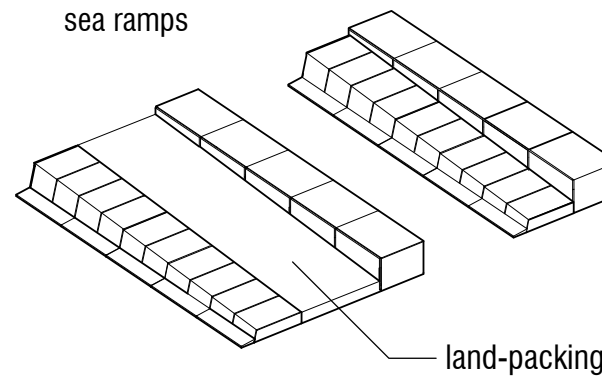
promenade



sea slope

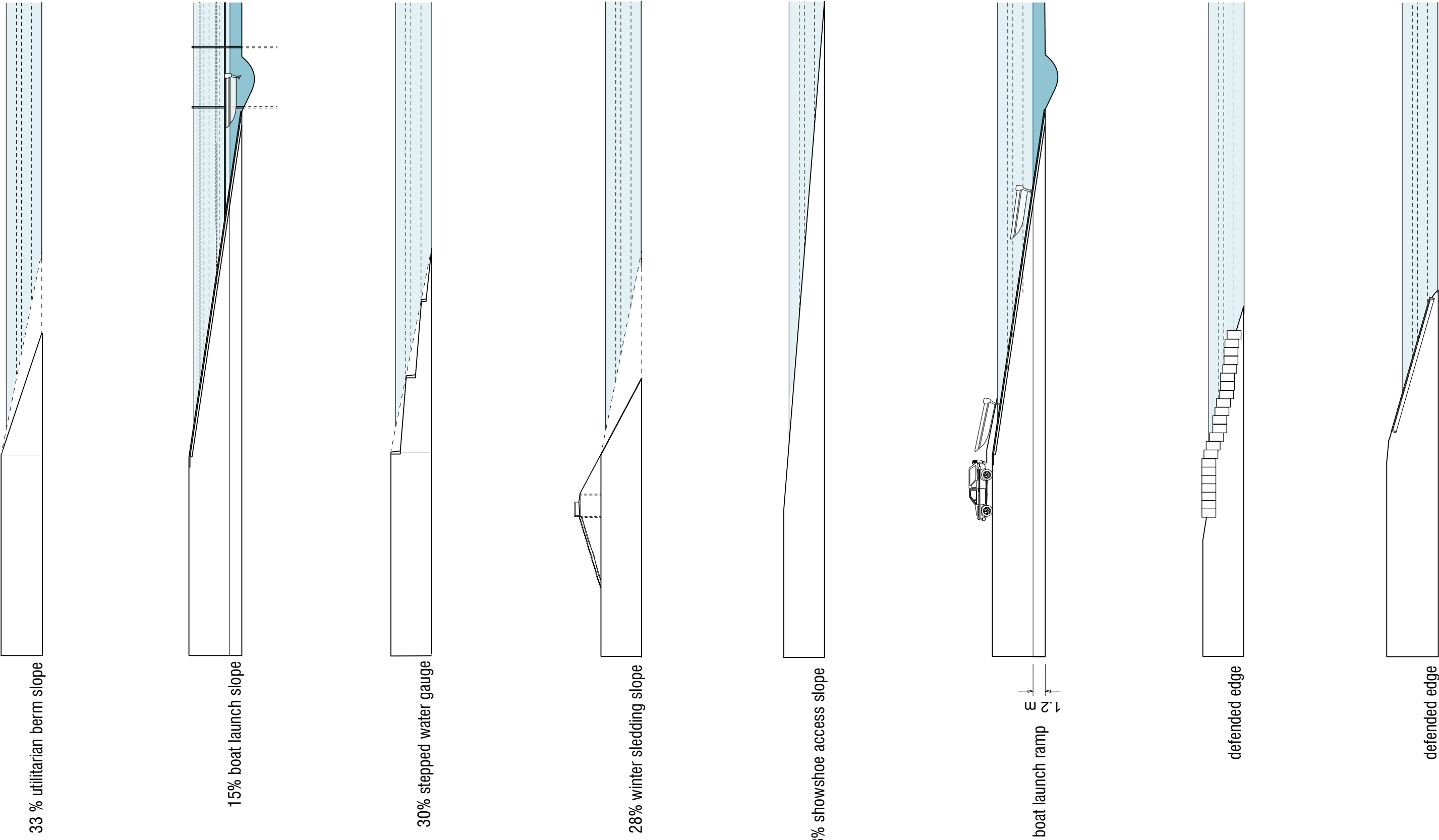


sea ramps

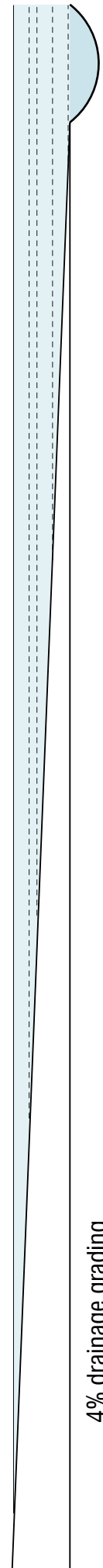


## CONSTRUCTING THE LAYERED EDGE

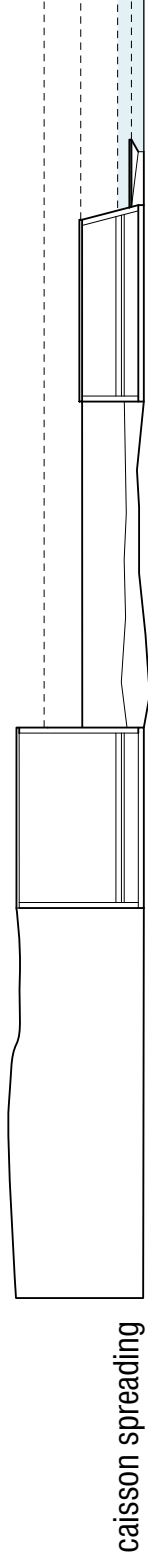
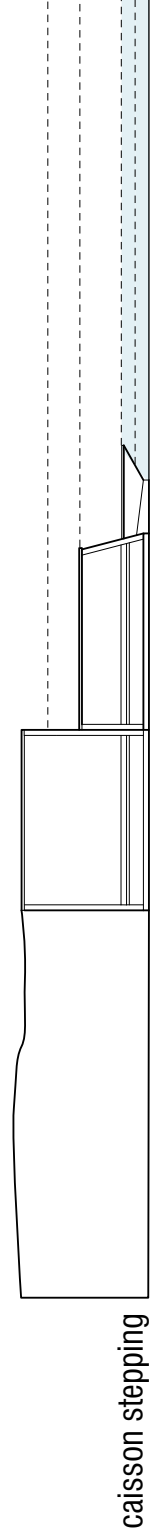
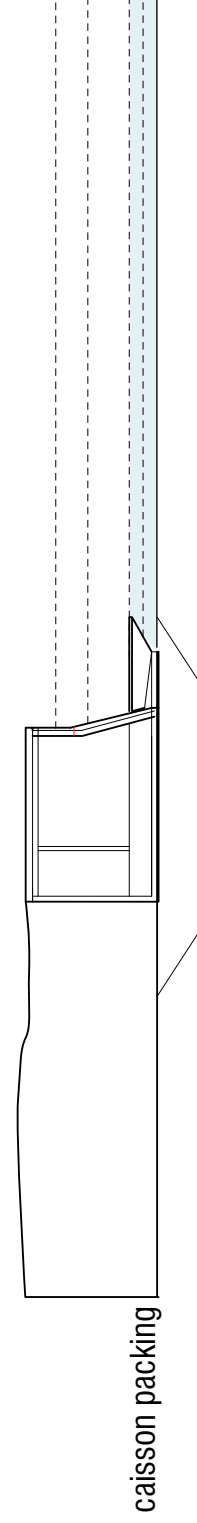
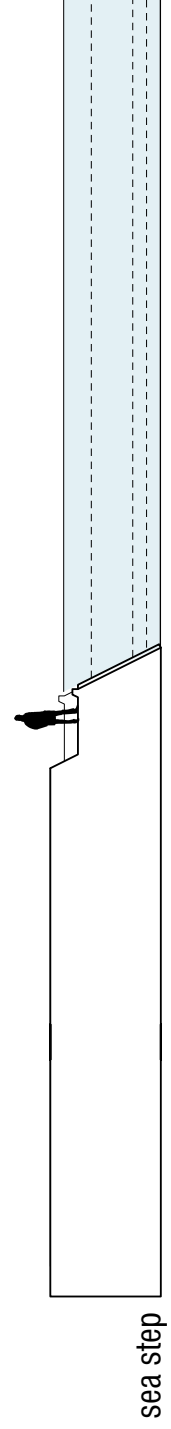
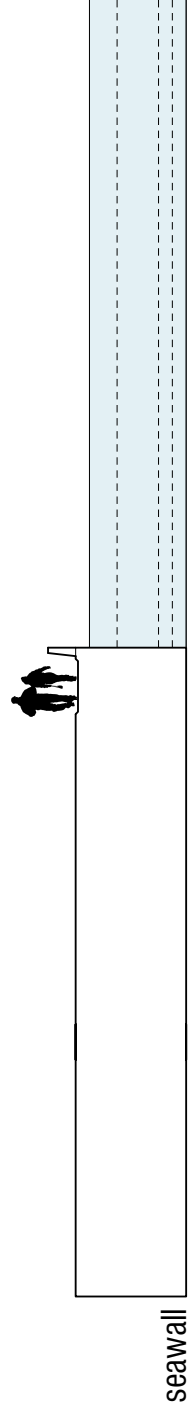
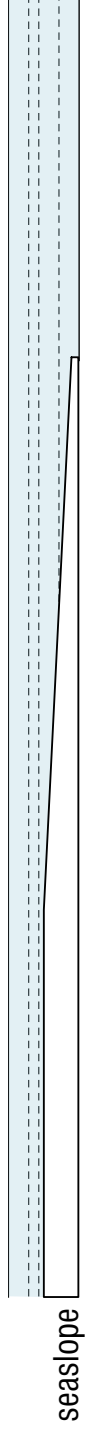
The design for a new Arctic urbanism under the financial and infrastructural surge of oil and gas development must embrace a flexible strategy that will construct a new urban edge through a series of gradients to the rising sea. Studying the existing edge condition at Tuktoyaktuk and how it has evolved over the century, it is clear that the community retains a critical connection to the water. Previous relocation strategies within the community have attempted to move the residential housing stock to higher ground. In most cases, this has been viewed as an unfavorable option for local residents. Instead, the vitality of their day-to-day living is connected to their means of accessing the sea - both visually and physically. The plan for the harbour in this way, acknowledges the needs of the industry for access, while constructing the needs of the local community for land reclamation, fishing, recreation and cultural harvesting practices. Therefore, the urban edge of the new Arctic town demonstrates a gradient of accessibilities and relationships to the sea. In this way, it is possible to imagine changing scenarios of use being activated over time. In a community that will become defended from - yet still remain vitally linked to - the sea, embracing and innovating this edge of access is of critical concern.



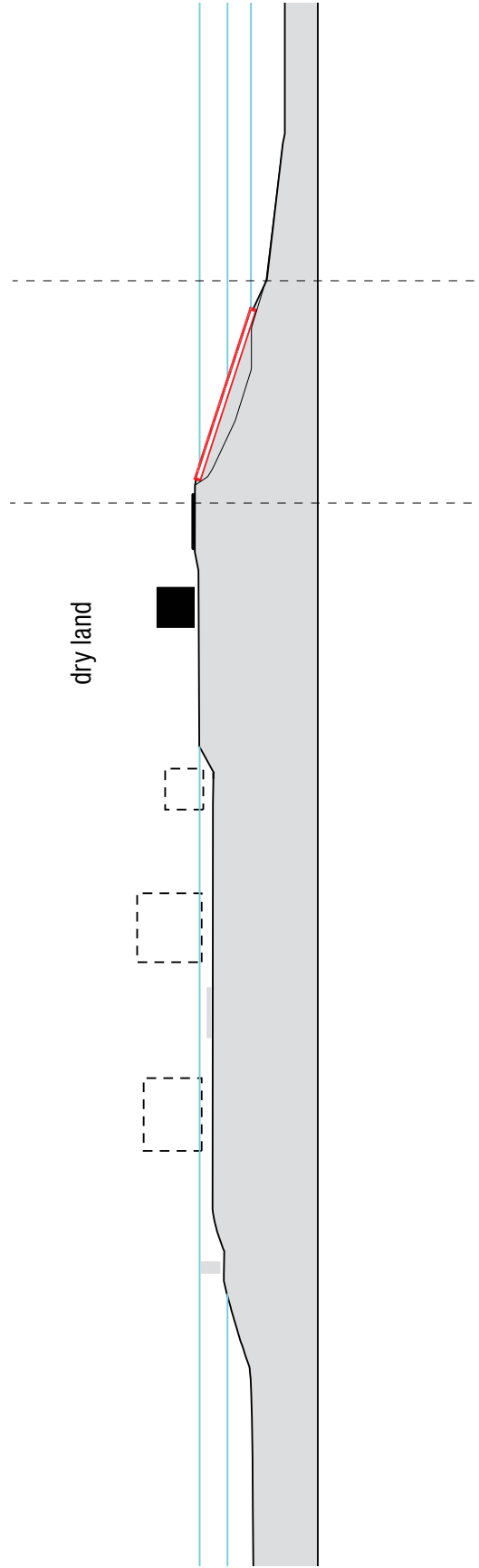
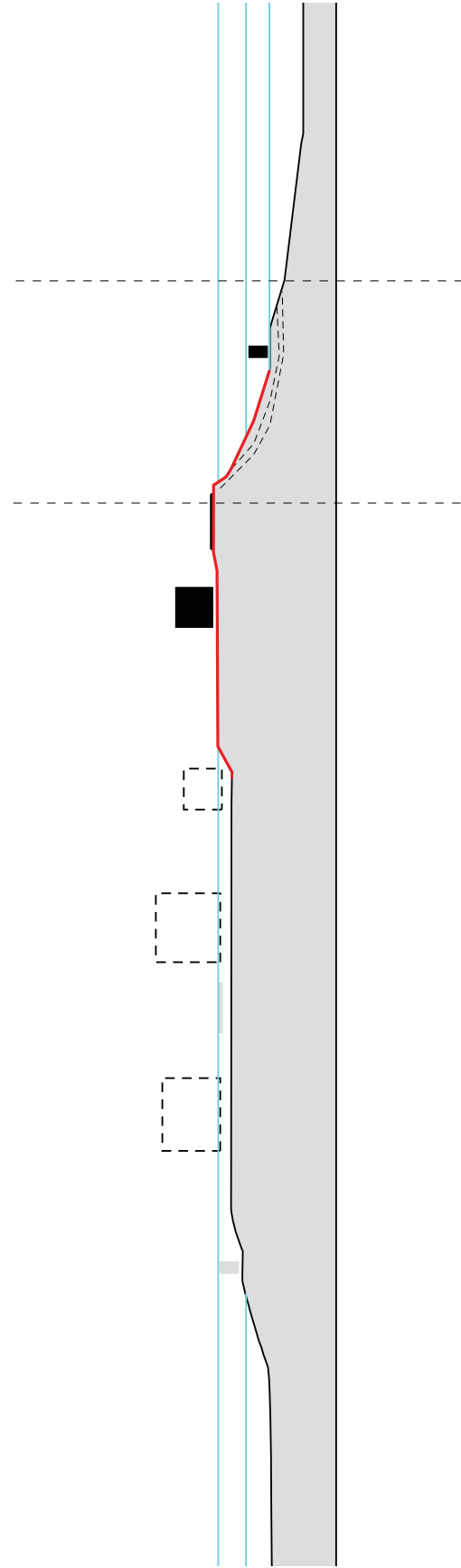
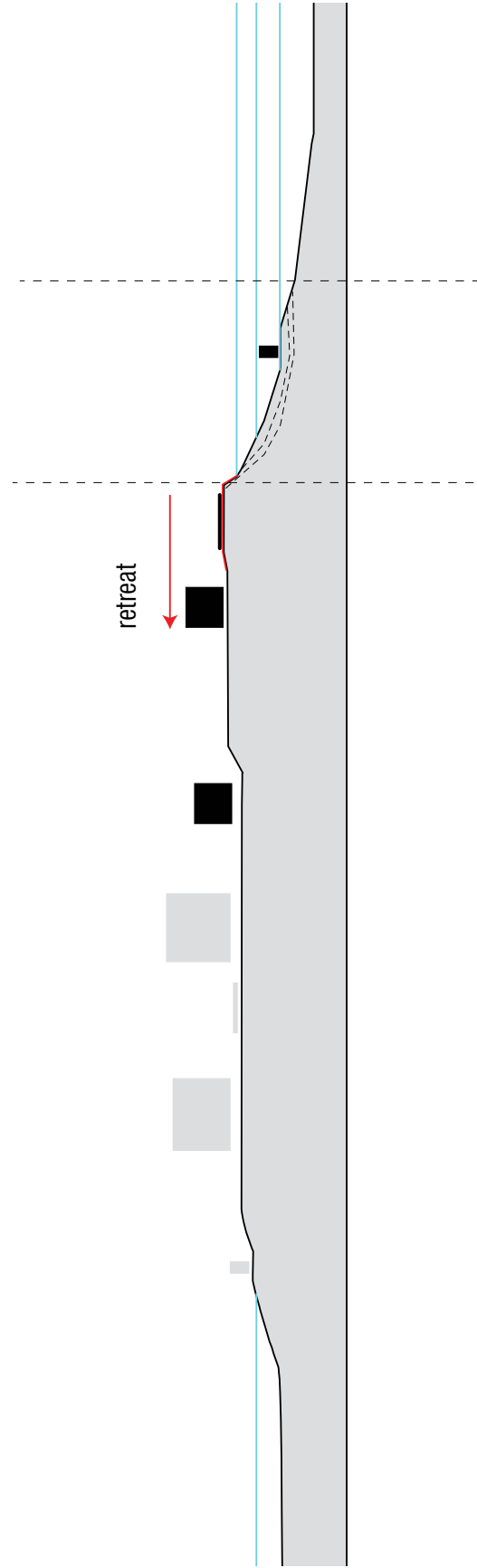
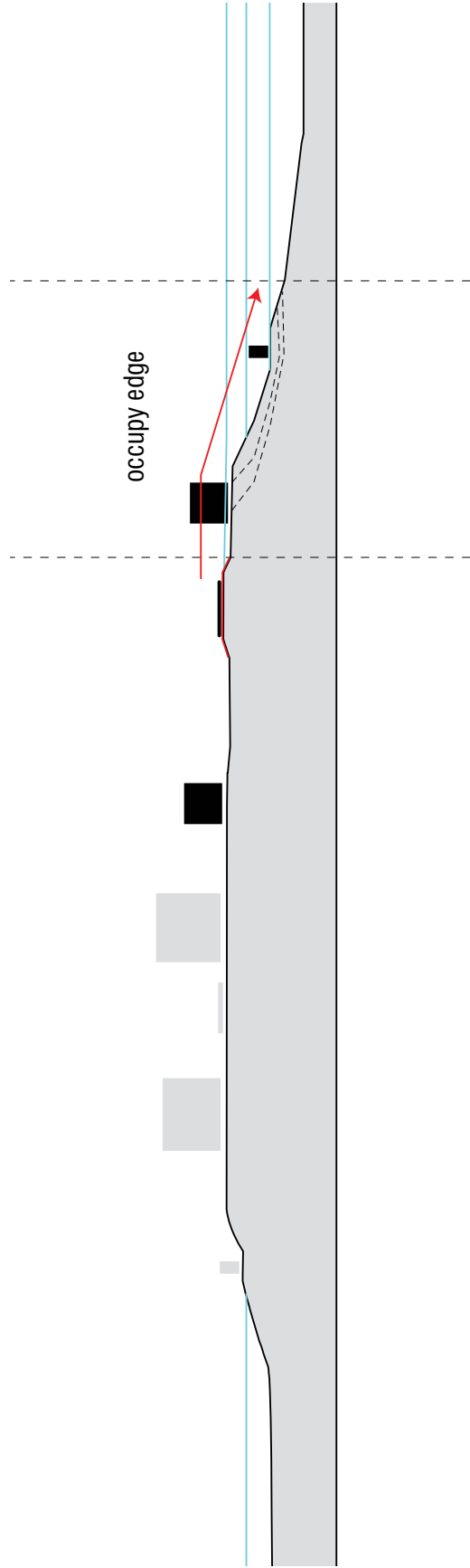
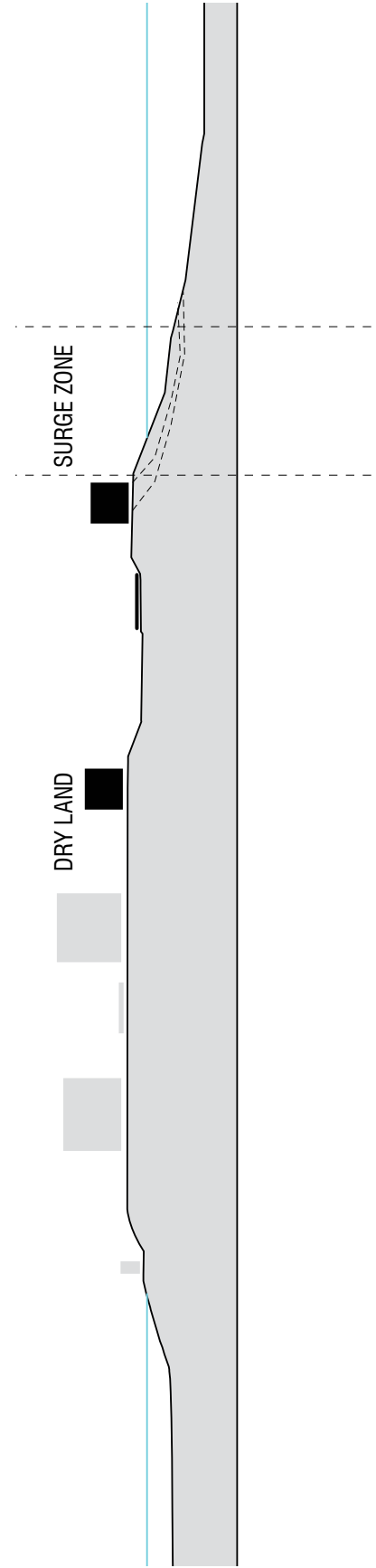




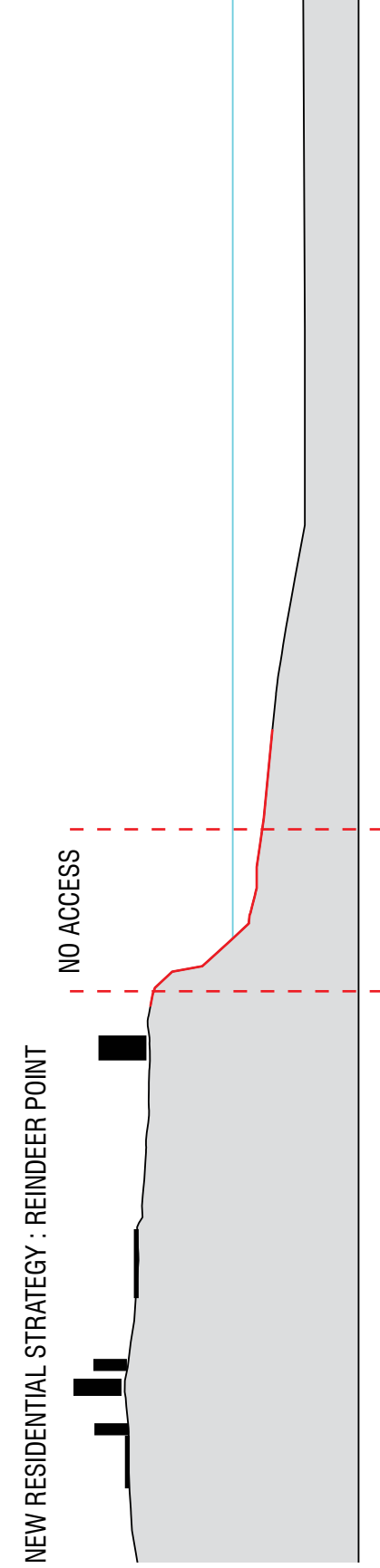
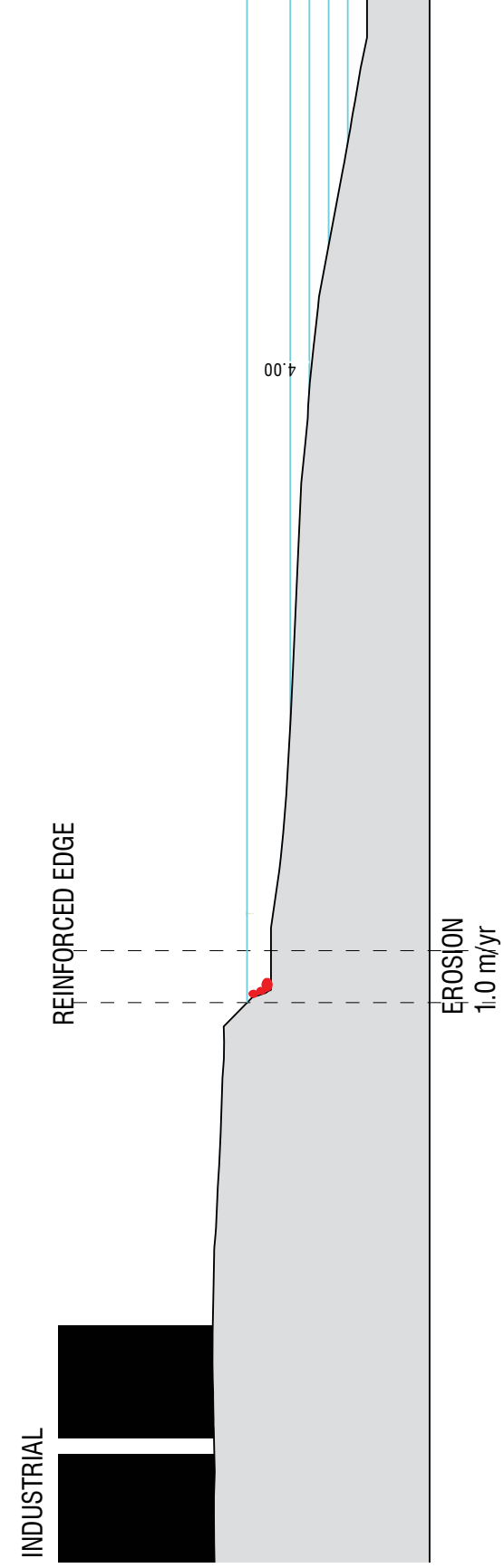
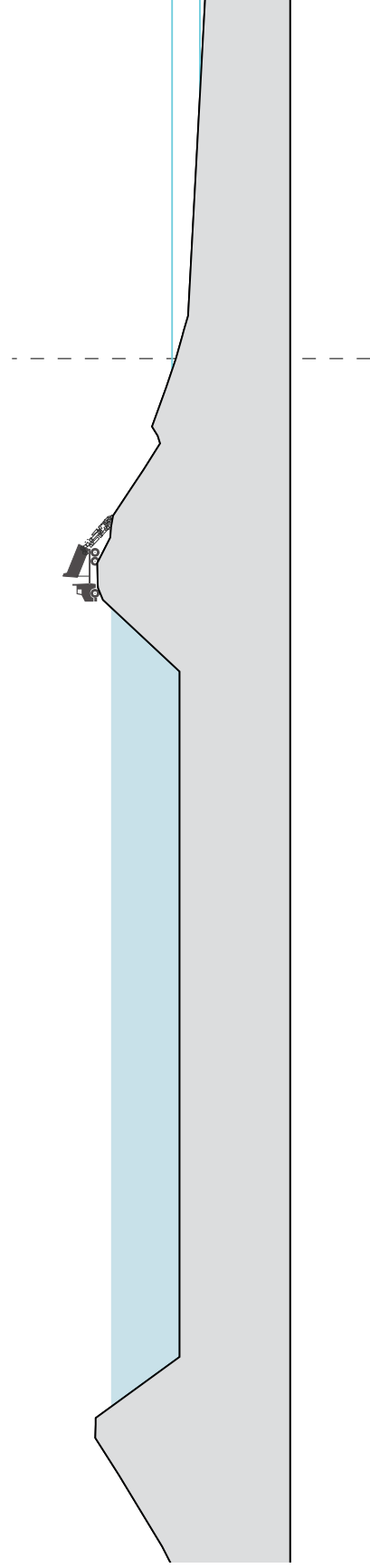
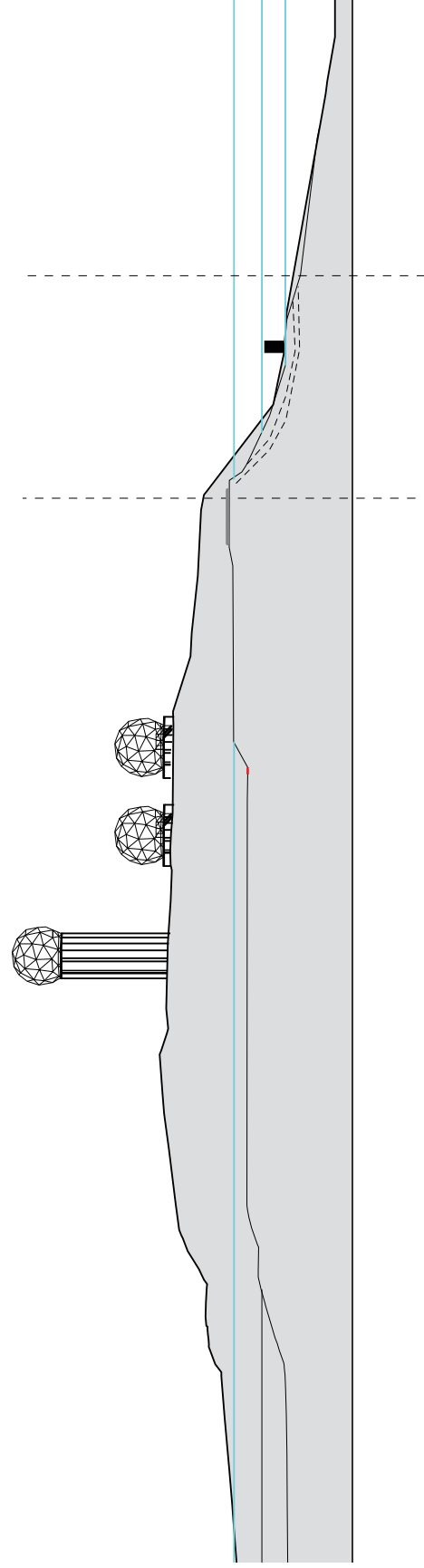
4% drainage grading



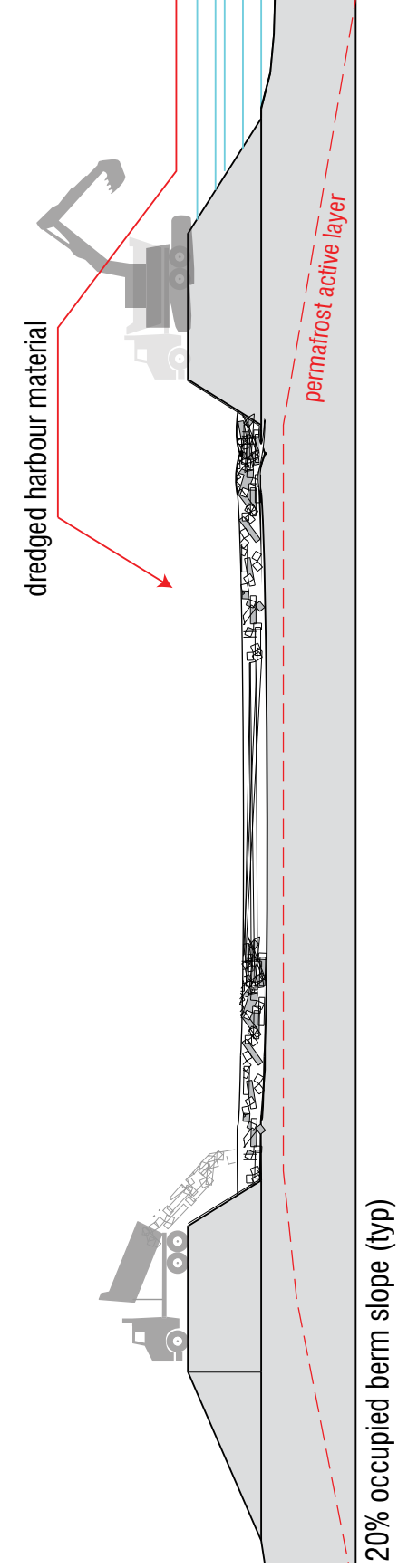
DEFENSIVE EDGE OCCUPATION THROUGH A LAYERED LANDSCAPE.



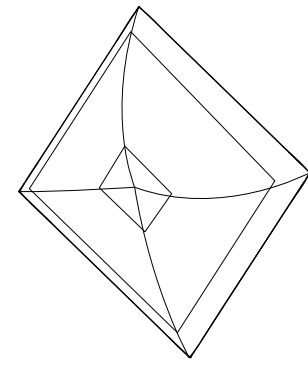




NEW RESIDENTIAL STRATEGY : REINDEER POINT

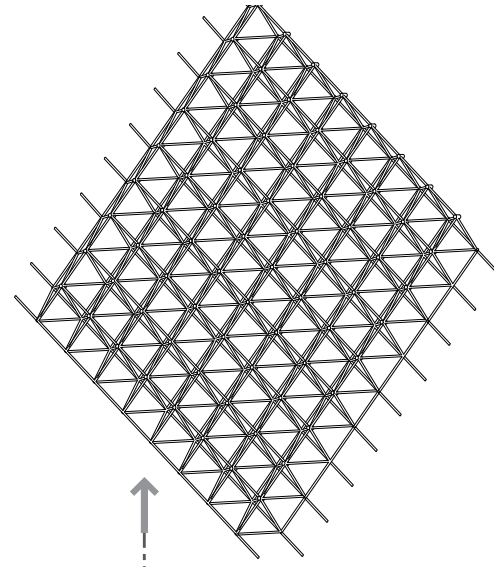
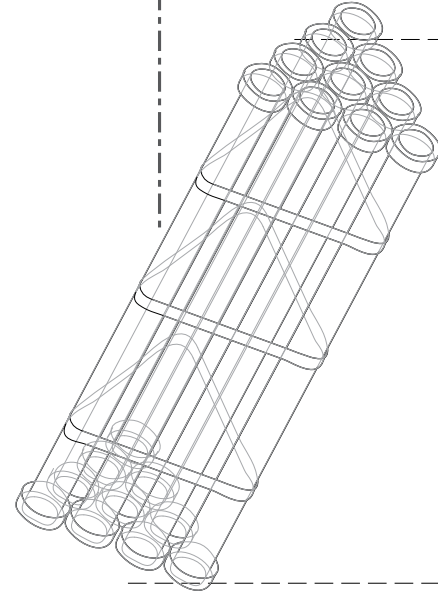


## SECTIONAL EVOLUTION OF THE COASTLINE :



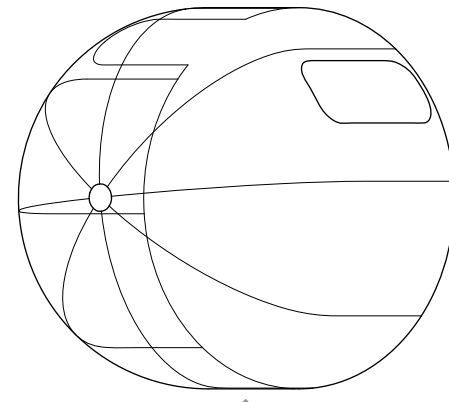
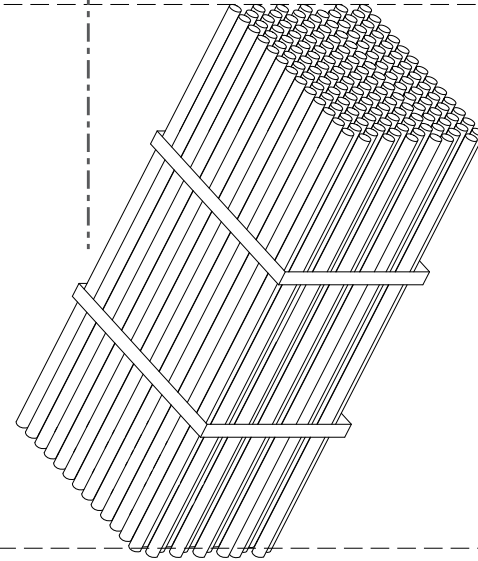
### ETFE TRANSPORTATION

material rolled onto bolts  
cannisters bundled and labeled per section to be assembled



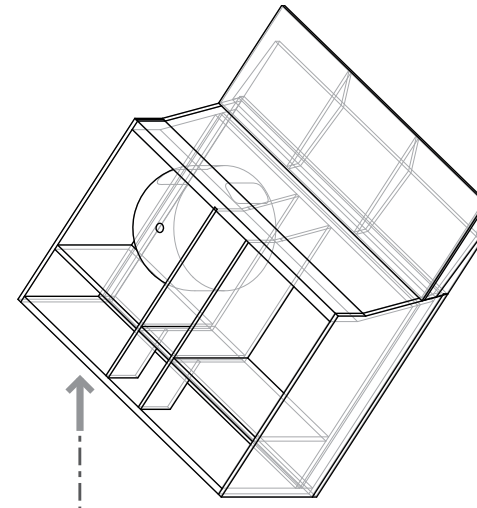
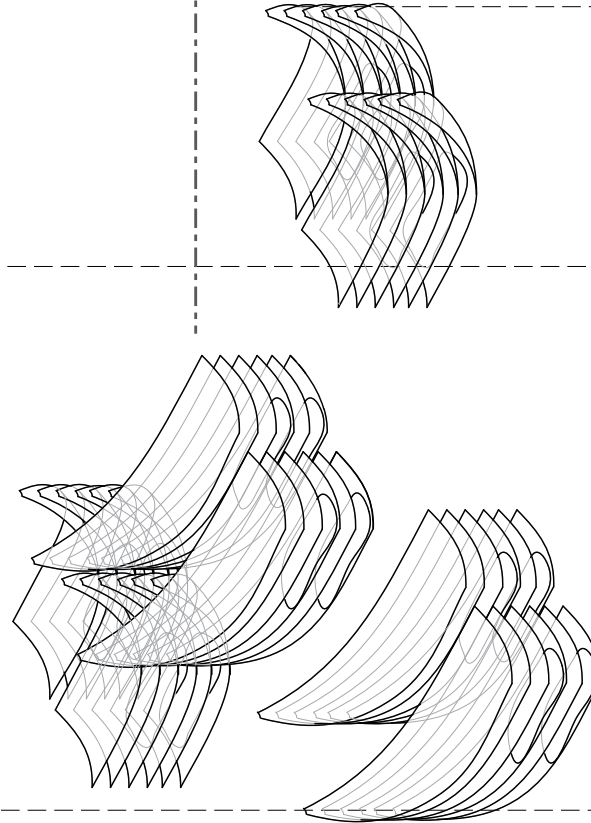
### SPACE FRAME TRANSPORTATION

ease of transportation  
on-site fabrication by unskilled labour  
ensures construction quality



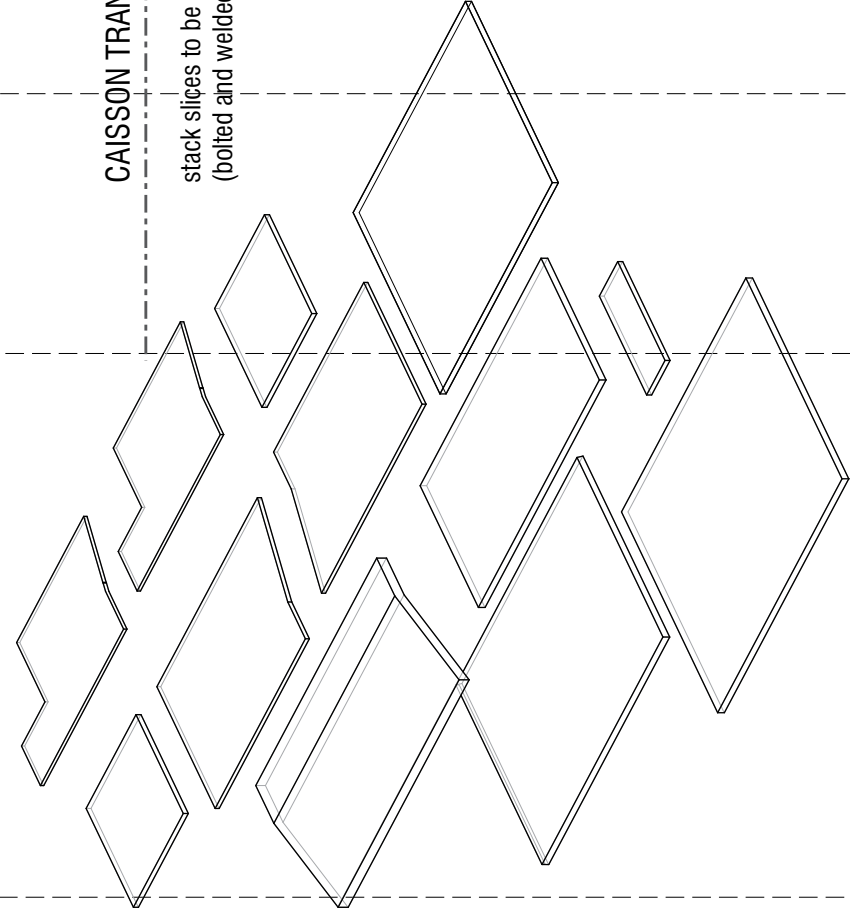
### POD TRANSPORTATION

stack slices to be assembled on site  
(bolted and welded strips)

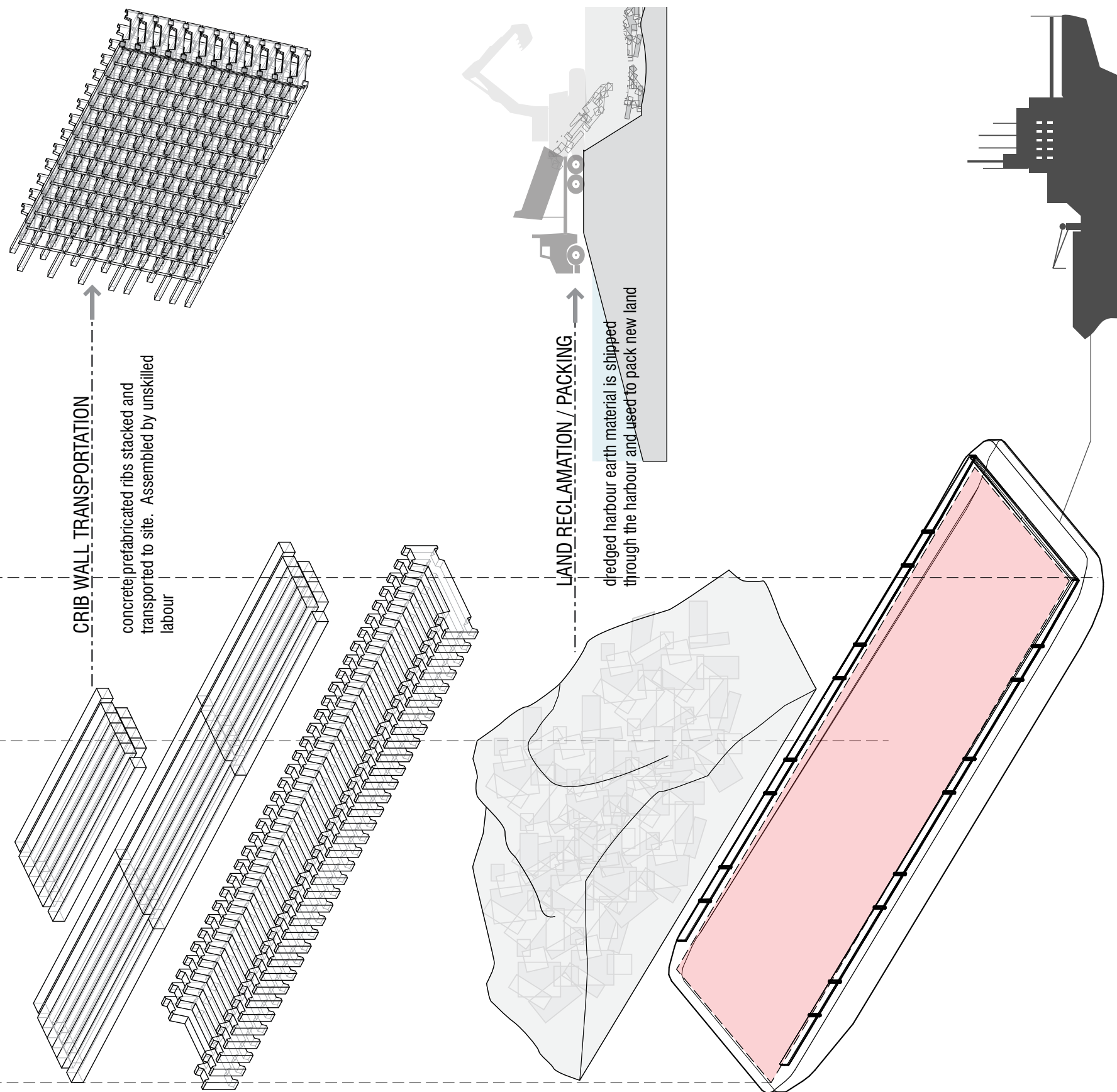


### CAISSON TRANSPORTATION

stack slices to be assembled on site  
(bolted and welded strips)







## ARCTIC LOGISTICS:

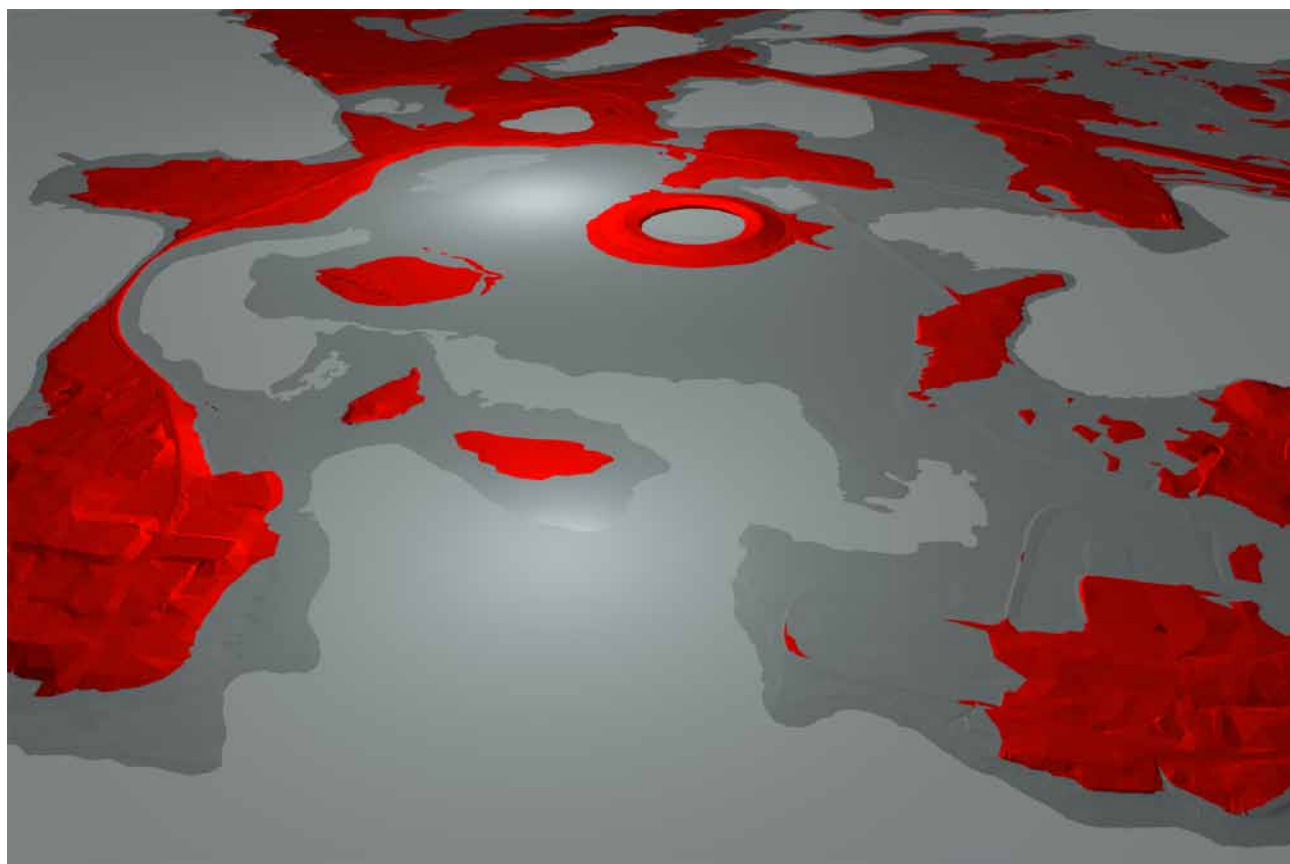
It is typical in remote locations to find construction capabilities and practices contingent on the particularities of access, shipping and skilled labour. For this reason, it is common in the Arctic for settlements to be constructed along a major, accessible waterway, or in the vicinity of a pre-existing landing strip, railway, or constructed roadway. The logistics of construction at Tuktoyaktuk serve not only its remoteness, but also the development and necessity of its marine infrastructure such that it might operate as a Northern shipping point for supplies coming up North on cargo barges from Hay River and the West Coast of Canada. Beginning with the removal and movement of dredged earth material from the harbour, barges will be used to move this earth to shore in the completion of the packing strategy for land reclamation. So too, will all the essential components to this design construction be shipped up to Tuktoyaktuk from the south on both deep-sea and shallow-draft barges. In this way, the use of flat-pack, stackable and pre-fabricated components was dutifully followed in all material selections. When presented with the challenges of remote logistics, architectural innovation must respond with strategies of pre-fabrication, ease of assembly, and considerable use of local materials found on the site. With the latter, the use of dredged material from the harbour as well as various landfill remediation zones throughout the newly constructed landscape, will serve to not only remediate the landscape but secure new land on which to construct a growing community.





# RESPONSIVE DESIGN FOR A NEW ARCTIC URBANISM

Through landscape, infrastructural,  
ecological and architectural layers



INUNDATION CONDITION (2050) WITHOUT SEAWALL INTERVENTION



LAND RECLAMATION WITH NEW URBAN EDGE



for program descriptions,  
please see p208

industrial waste  
processing and  
containment plant

breakbulk and HAZMAT  
packing plant

landfill containment  
wastewater  
treatment  
ponds

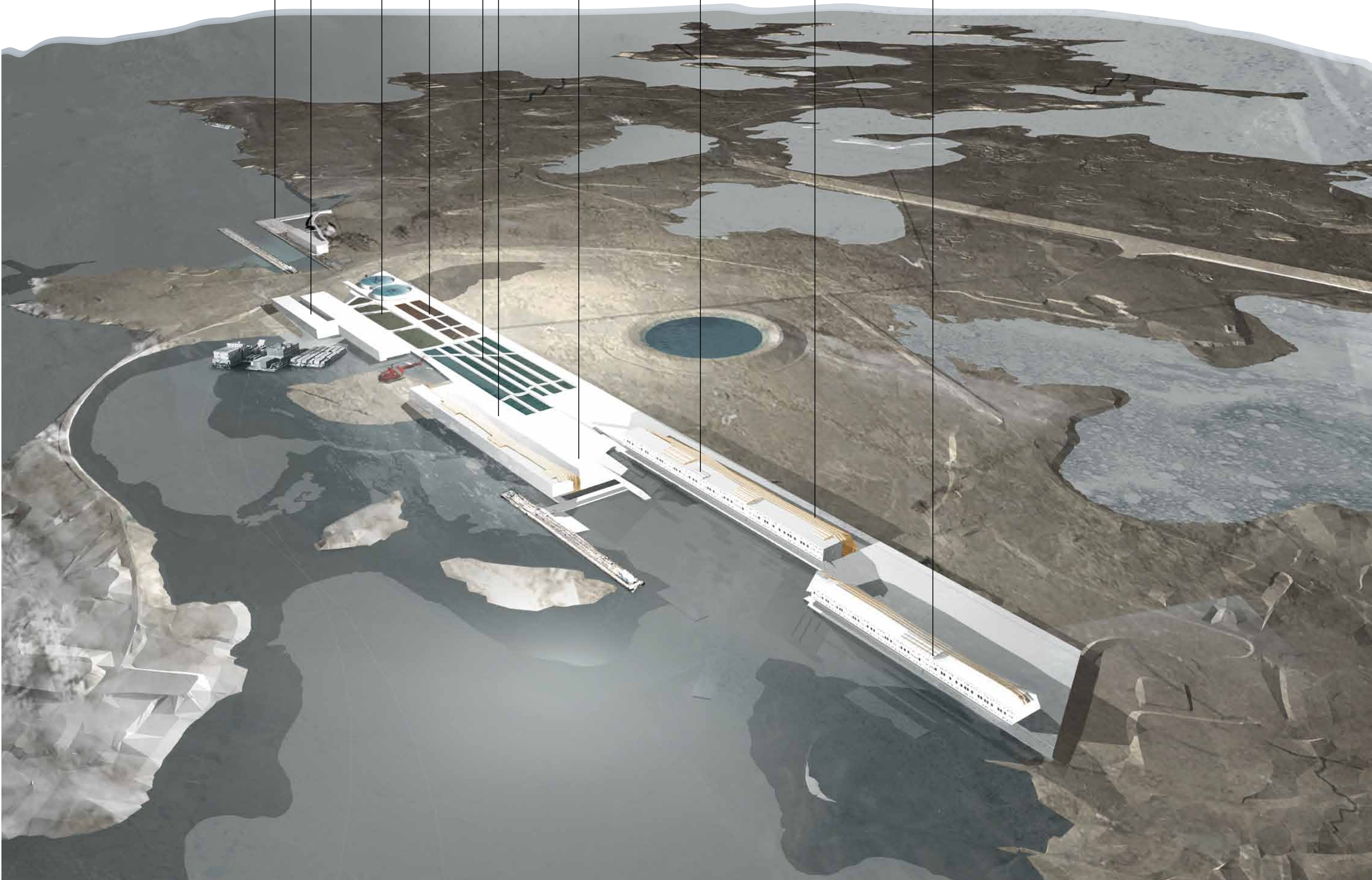
char farming  
Canadian Coastguard  
Arctic Div

Tuk Market and  
Distribution Centre

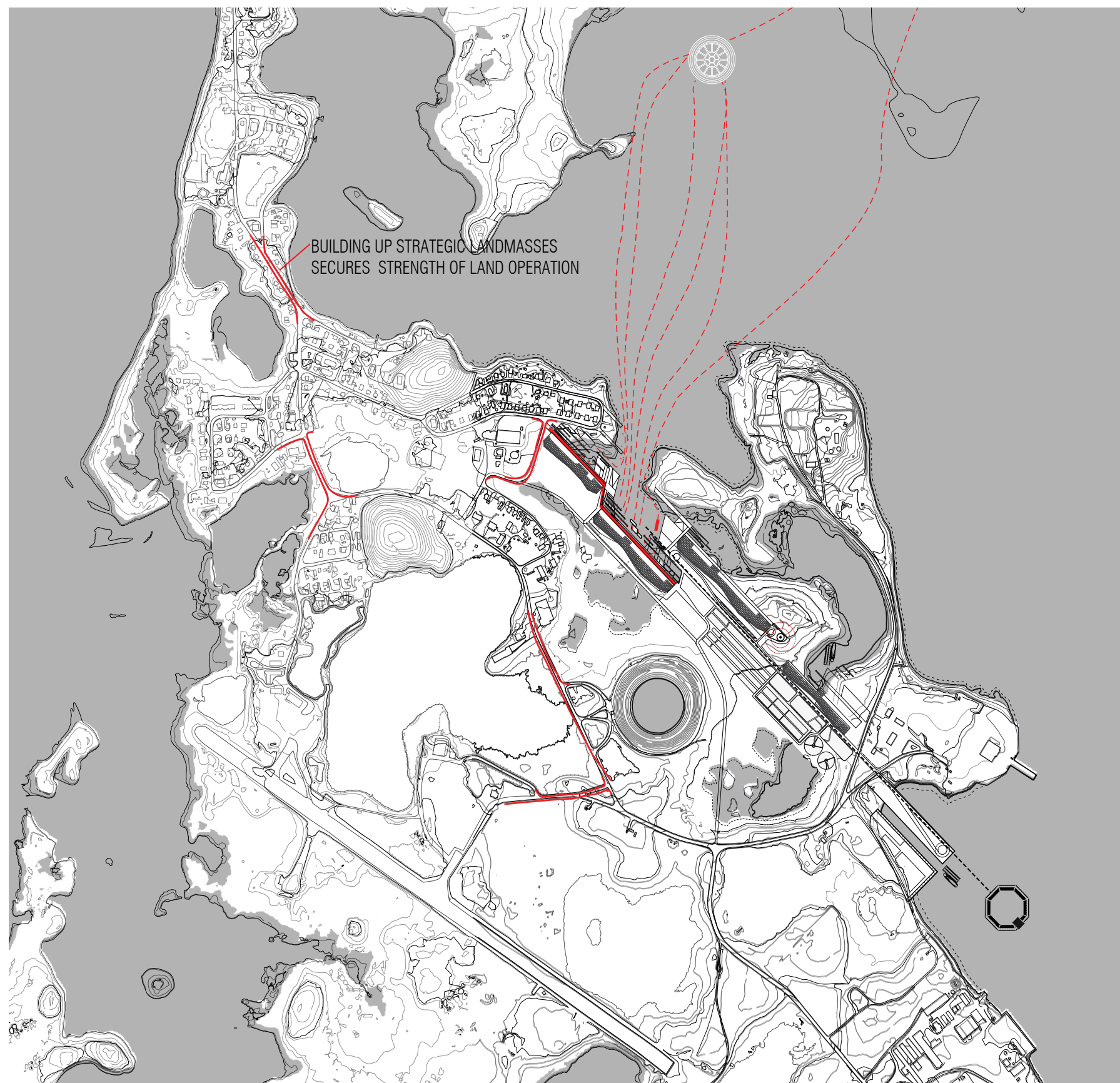
local housing and  
productive greenhouse

local housing and  
productive greenhouse

local housing and  
civic spaces





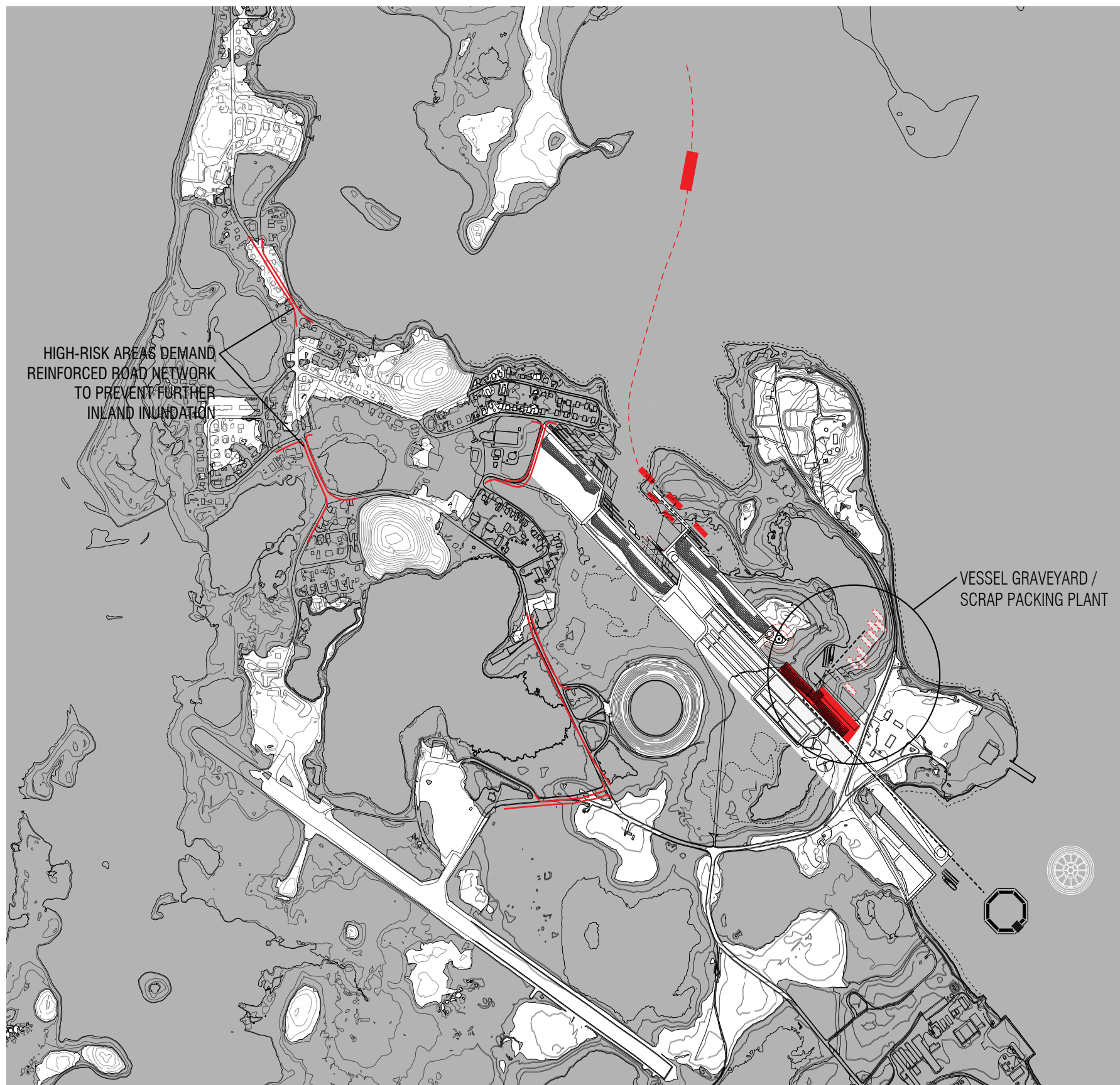


SCENARIO OF USE : 2015 MEAN SEA LEVEL

## OIL OCCUPATION / HARBOUR DEVELOPMENT

ACTIVATION OF SEAWALL AND GRADIENT CREATES A SMALL-CRAFT HARBOUR FOR BOTH TRANSIENT AND PERMANENT RESIDENTS.

OFFSHORE OIL DEVELOPMENT, ONSHORE FOOD PRODUCTION , AND LAND RECLAMATION STRATEGIES THROUGH SMALL-DRAFT CARGO BARGES.



SCENARIO OF USE : 2050 SEA LEVEL RISE @ 2m

## POST-OIL OCCUPATION AND ECONOMY

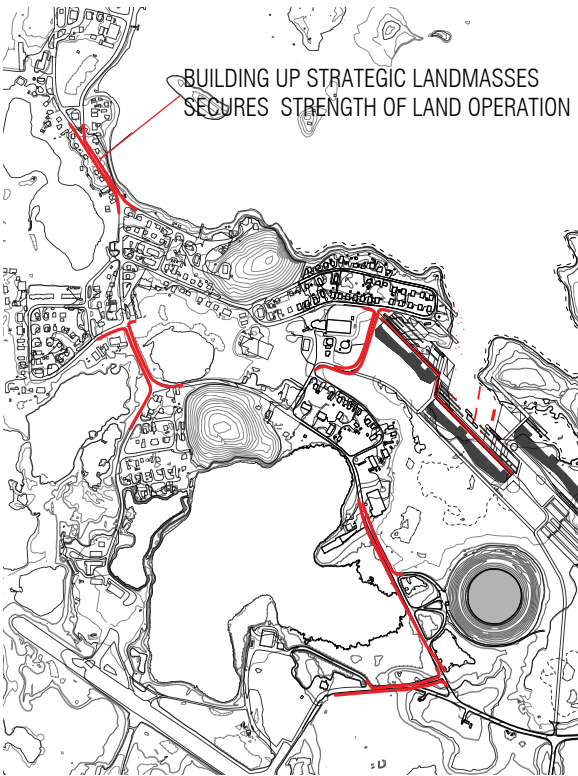
PORT OCCUPATION AND MARINE ECONOMY INVOLVED IN :

FOOD PRODUCTION, HIGH ARCTIC DISTRIBUTION CENTRE, VESSEL GRAVEYARD (INCLUDING WASTE PACKING AND SHIPPING PLANT) AND SITE REMEDIATION OF DISTURBED AREAS.



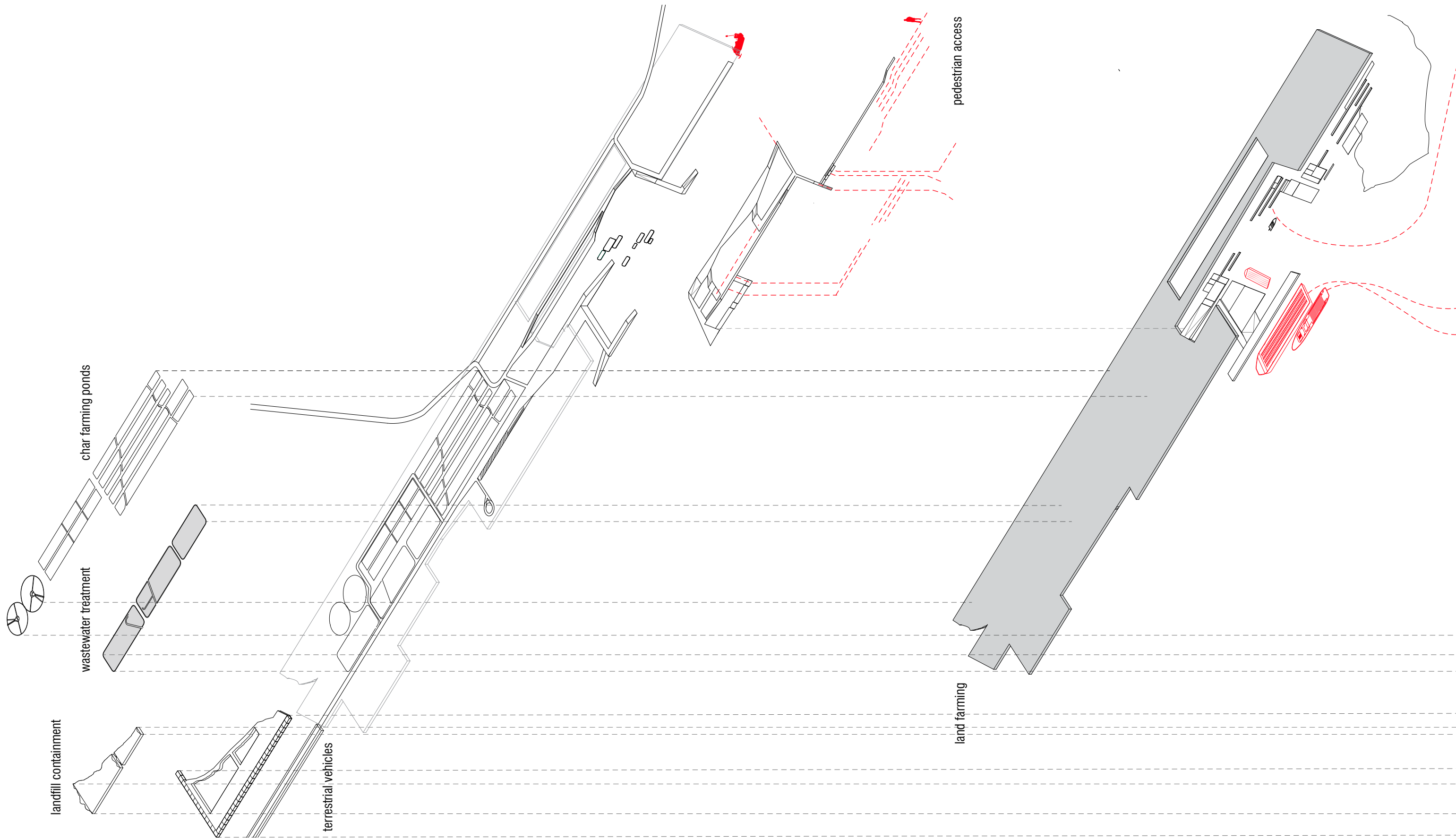
DEFENSIVE LAND STRATEGIES :

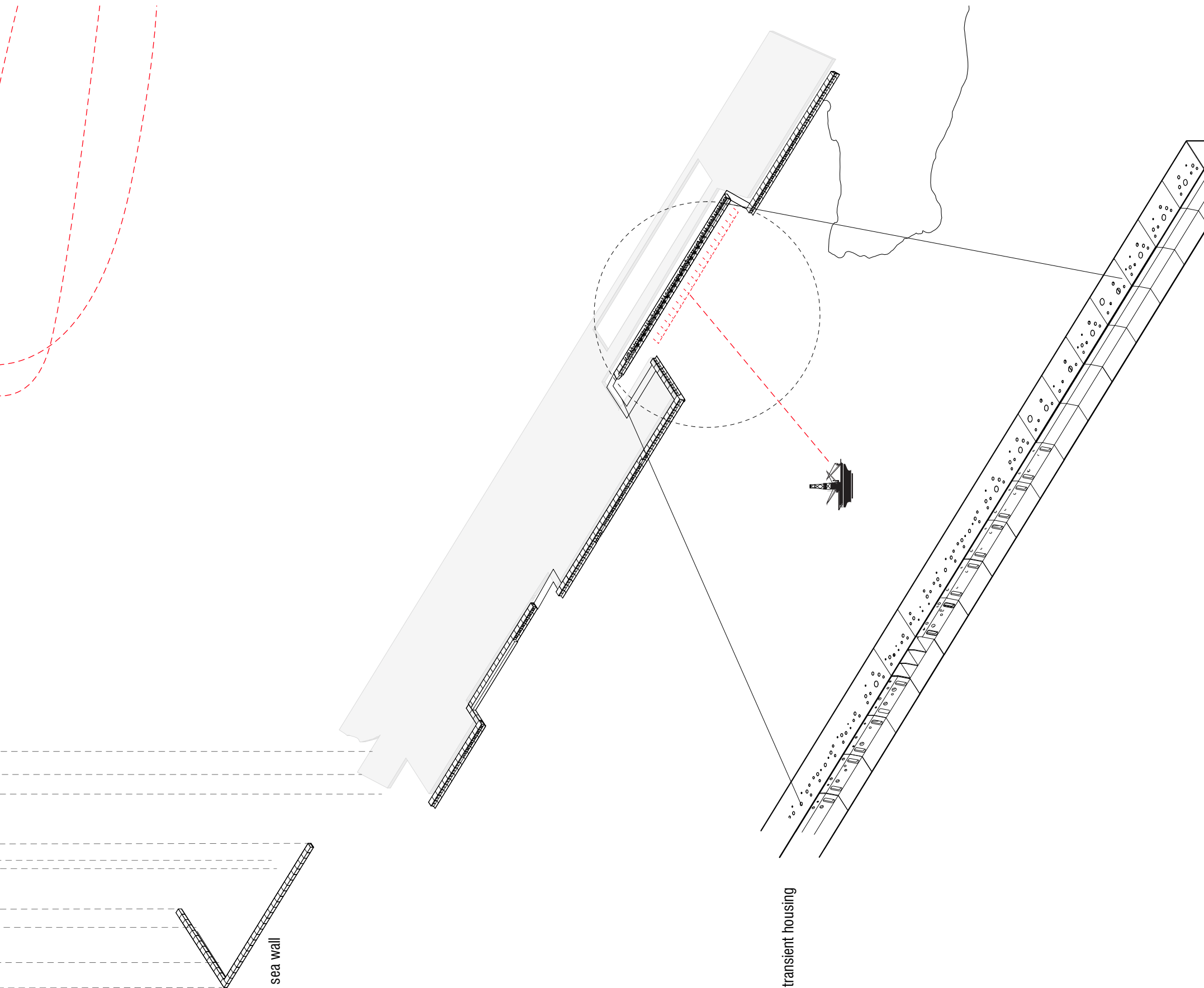
Coupled with the edge strategy for land reclamation and harbour occupation, comes the need for defensive land strategies across the community in order to prevent inundation and loss of accessibility throughout Tuk. This will occur through the reconstruction and lifting of roads and certain patches of land to heights above the rising sea-level. Typical berm strategies utilizing geotextiles and landpacking help to construct a reliable barrier throughout the community to defend it against the rising tides.









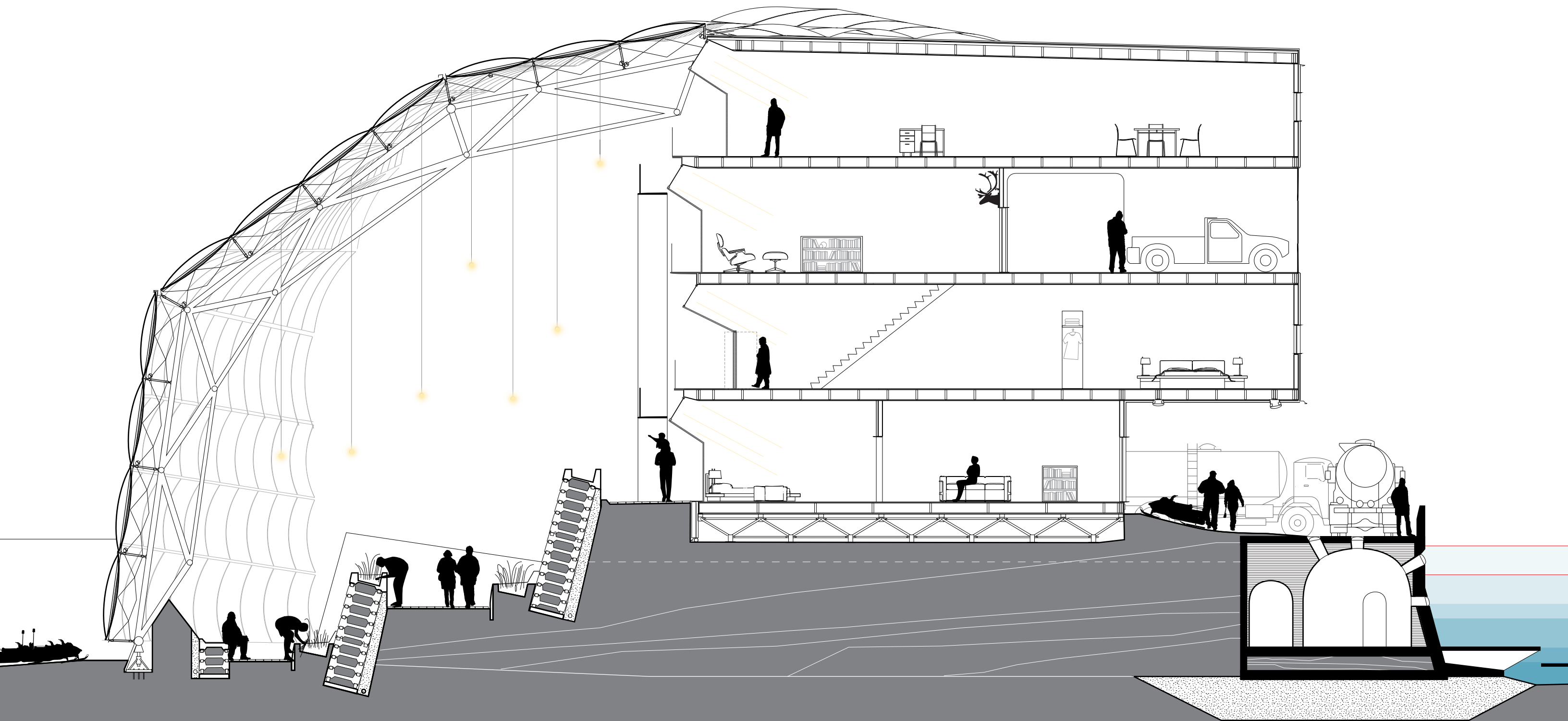


## CHOREOGRAPHING OCCUPATION

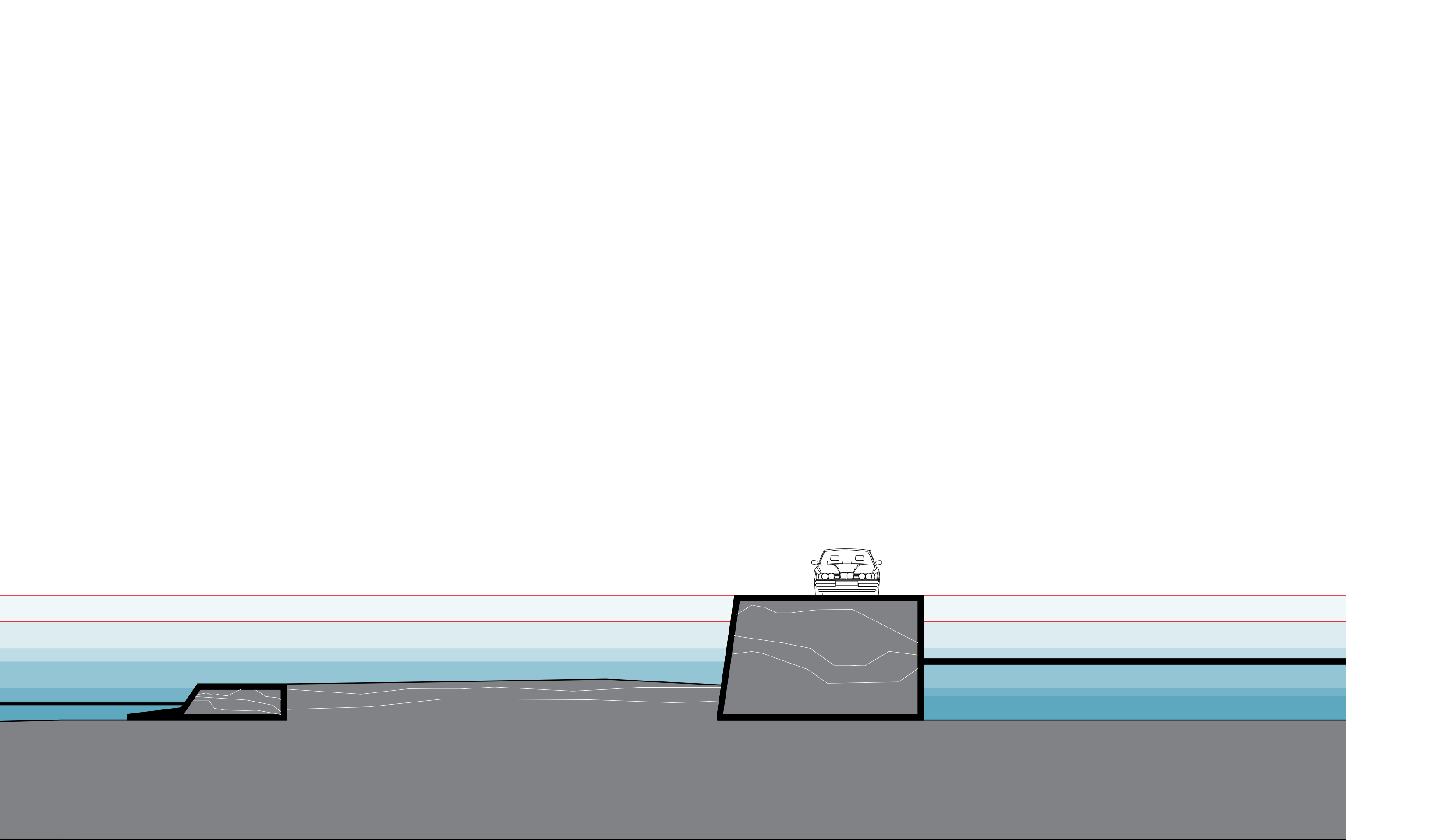
By utilizing a layered edge strategy, this thesis aims to successfully weave the operations and flows of occupants on the site. The ability for the caisson seawall structure to retain land and also provide access to the water allows it to connect several modes of transportation within the section of the edge. The edge is able to transition from dock to dike to dry land, allowing a multitude of occupations to co-exist.

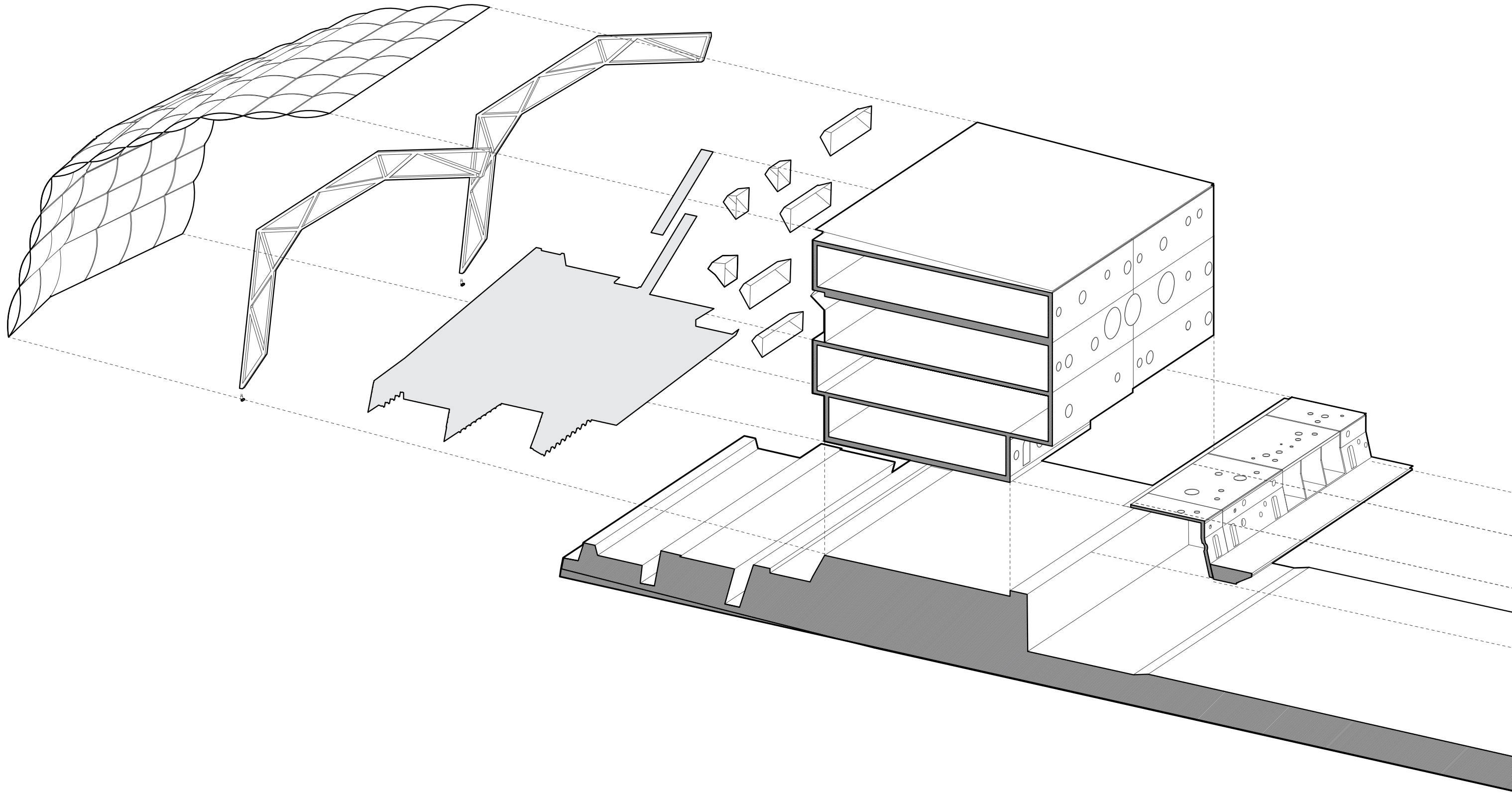
## LAND RECLAMATION FROM A DEFENSIVE EDGE





SITE SECTION : THE LAYERED EDGE : THE HOME







# THE HOME:

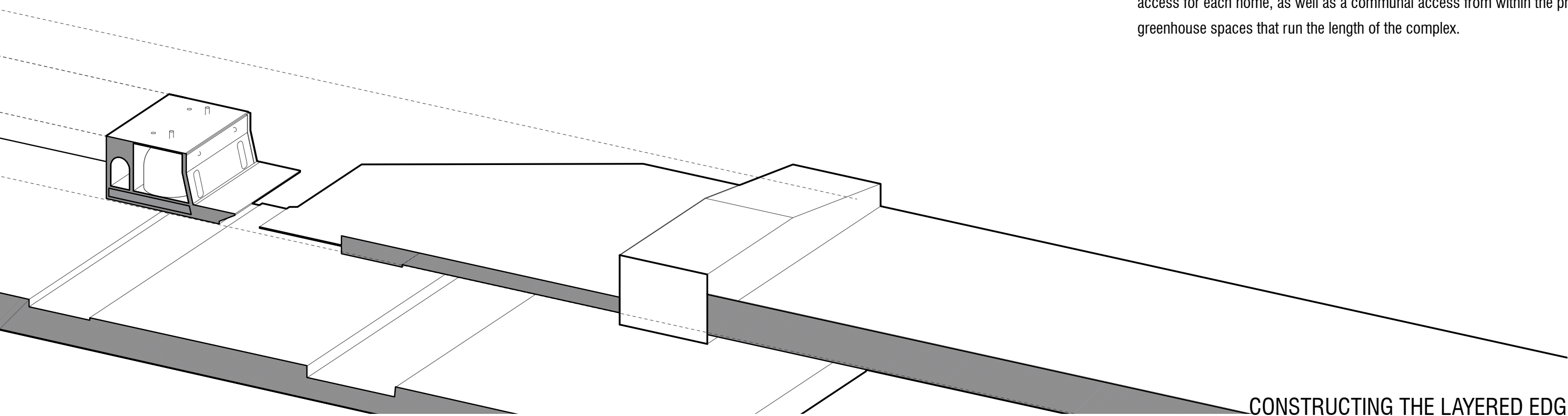
## HOUSING REQUIREMENTS ;

Onshore, temporary housing for 150 oil and gas workers for the next 40 years.

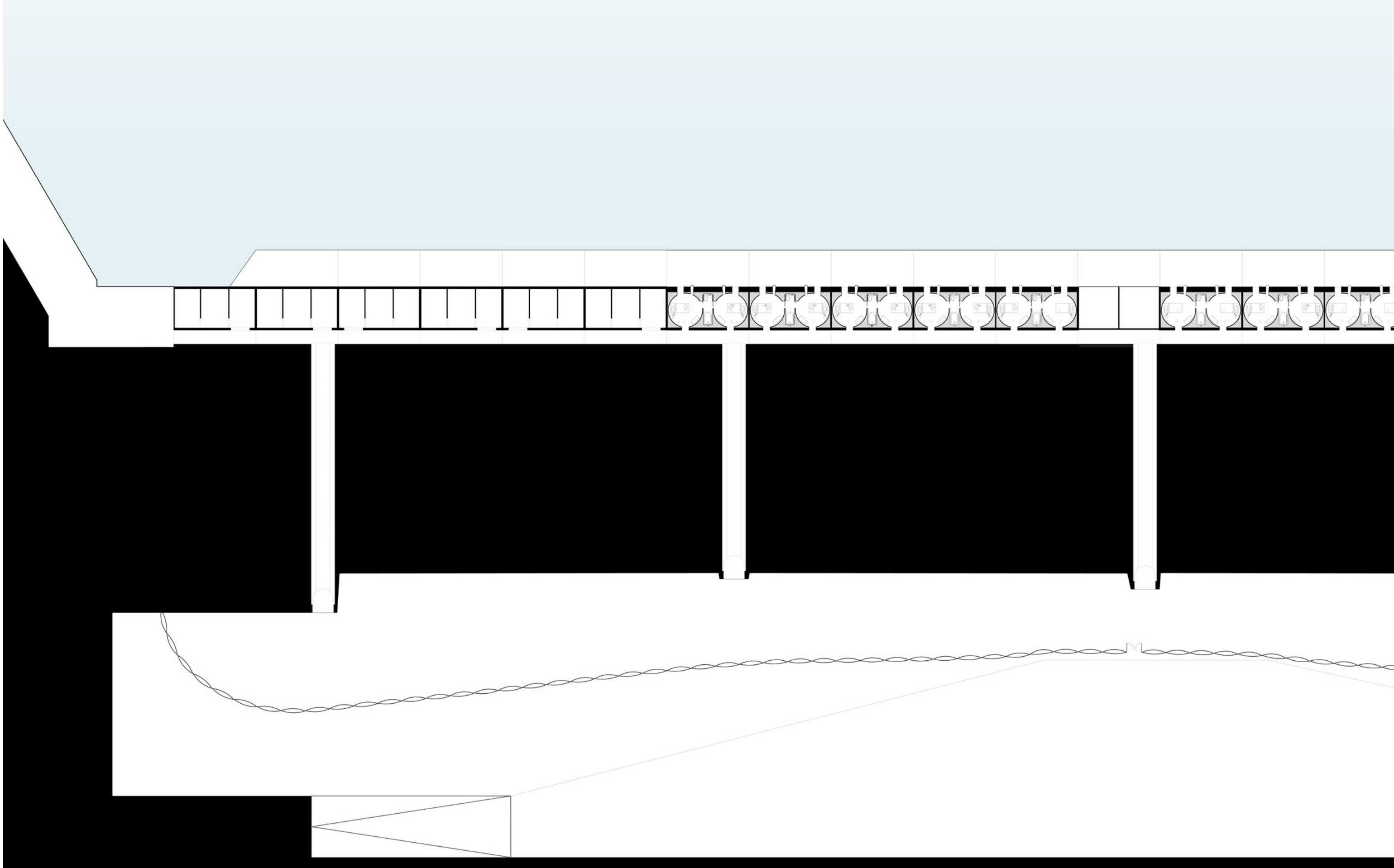
Permanent homes for 150 families to meet the current local population growth and the renewal of Tuk’s inadequate housing stock.

The design of the new Arctic industrial “mancamp” responds to a rapid influx of temporary, transient workers whose occupation of Tuk will carry through the duration of the oil operations. In this way, the construction of the temporary units is coupled with the construction of the seawall. In the event of sea-level rise over the next 50 years, these units might become inaccessible, though occurring after the retreat of the industry. In the meantime, they function as individual pods constructed within the caisson structure, giving the oil workers direct access to the harbour.

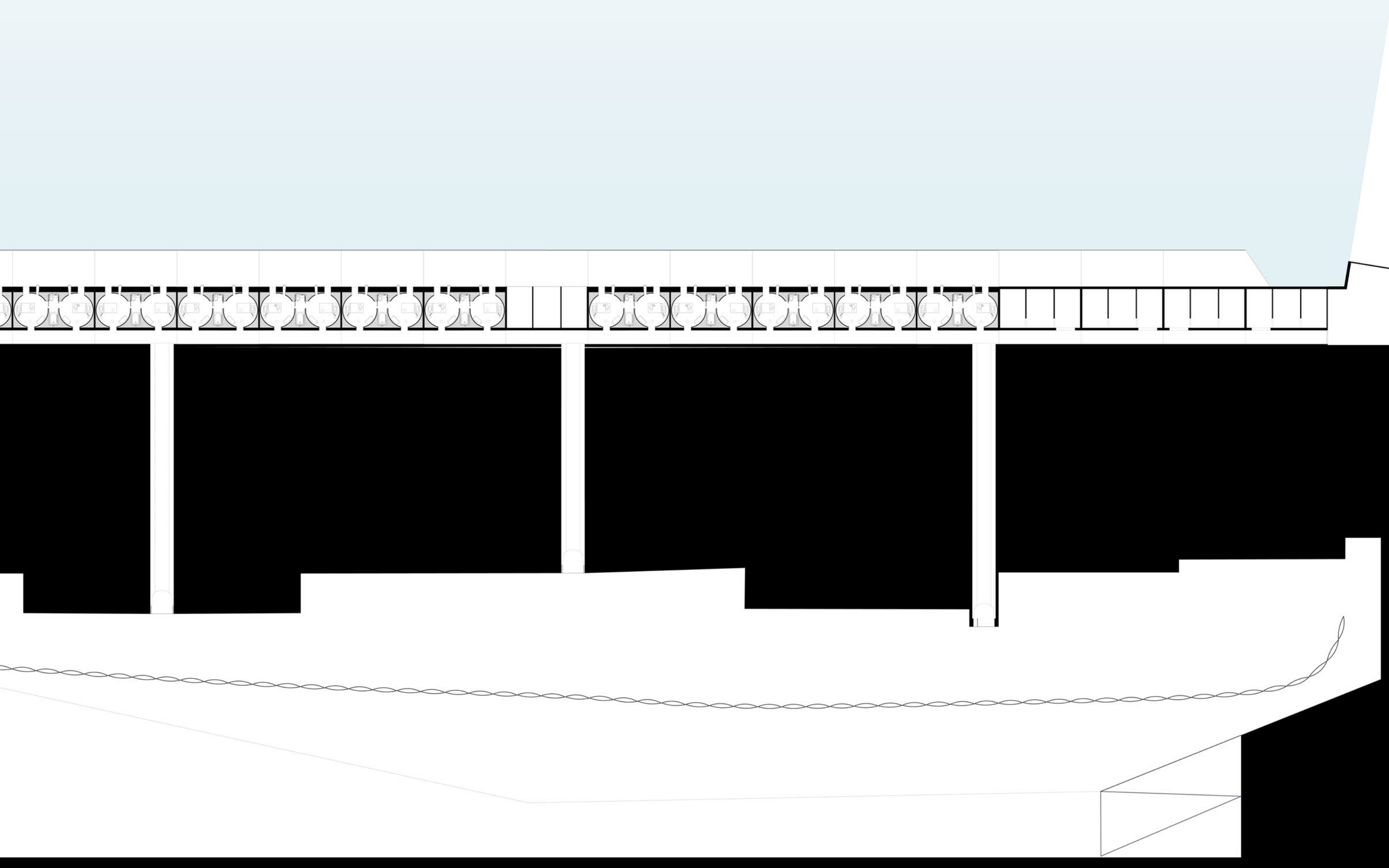
The design of the new Arctic family dwelling creates a hybrid condition that plays off of the single-family dwelling as well as the desire for communal, climate-controlled social space. The design of the housing units provides sheltered, private vehicular access for each home, as well as a communal access from within the productive greenhouse spaces that run the length of the complex.



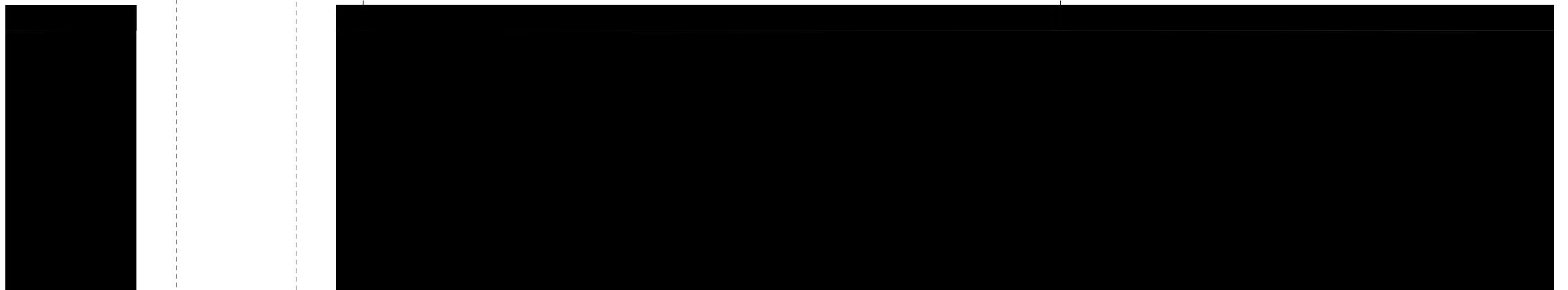
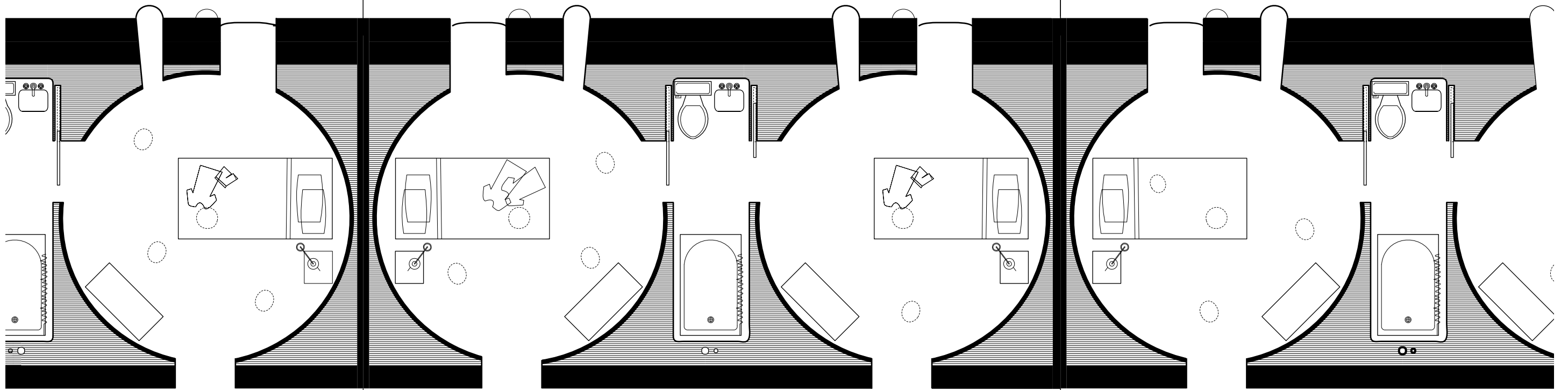
## CONSTRUCTING THE LAYERED EDGE



PLAN : SUBTERRANEAN LEVEL (1m ABOVE M.S.L.)







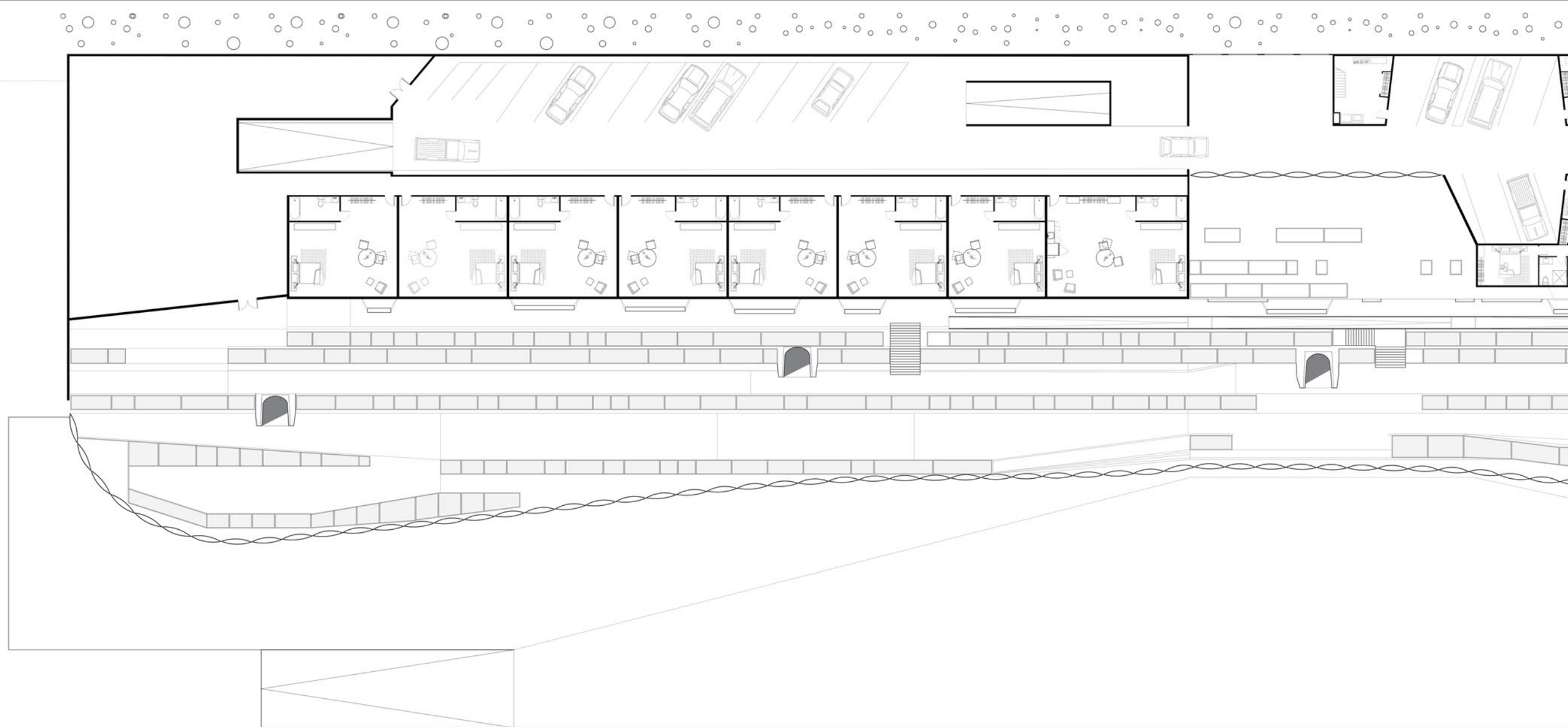
PLAN DETAIL : TEMPORARY HOUSING PODS



INSIDE WORKERS' HOUSING POD

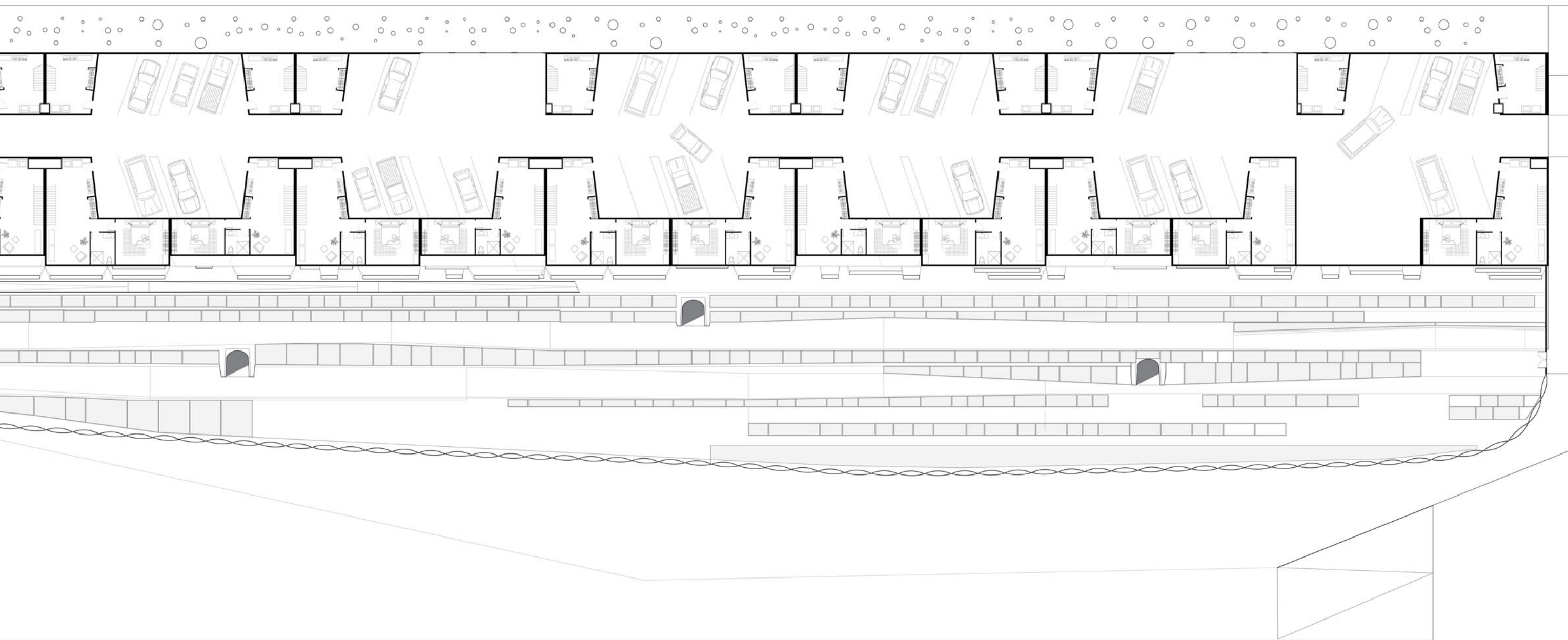






PLAN : GROUND-LEVEL (4m ABOVE M.S.L.)







PLAN DETAIL : PERMANENT HOUSING STRATEGY

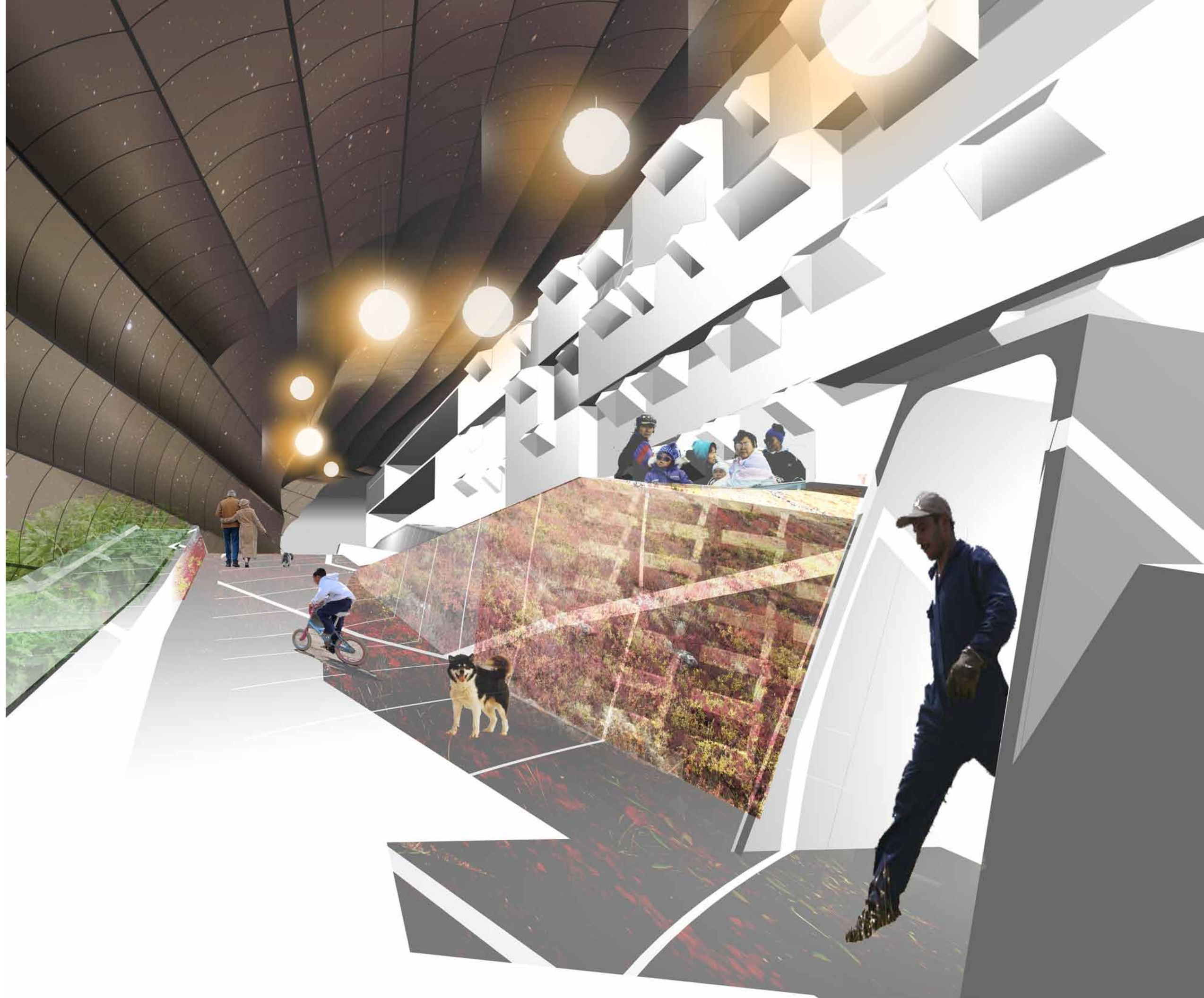
OPPOSITE: HOUSING UNIT IS ILLUMINATED BY GREENHOUSE







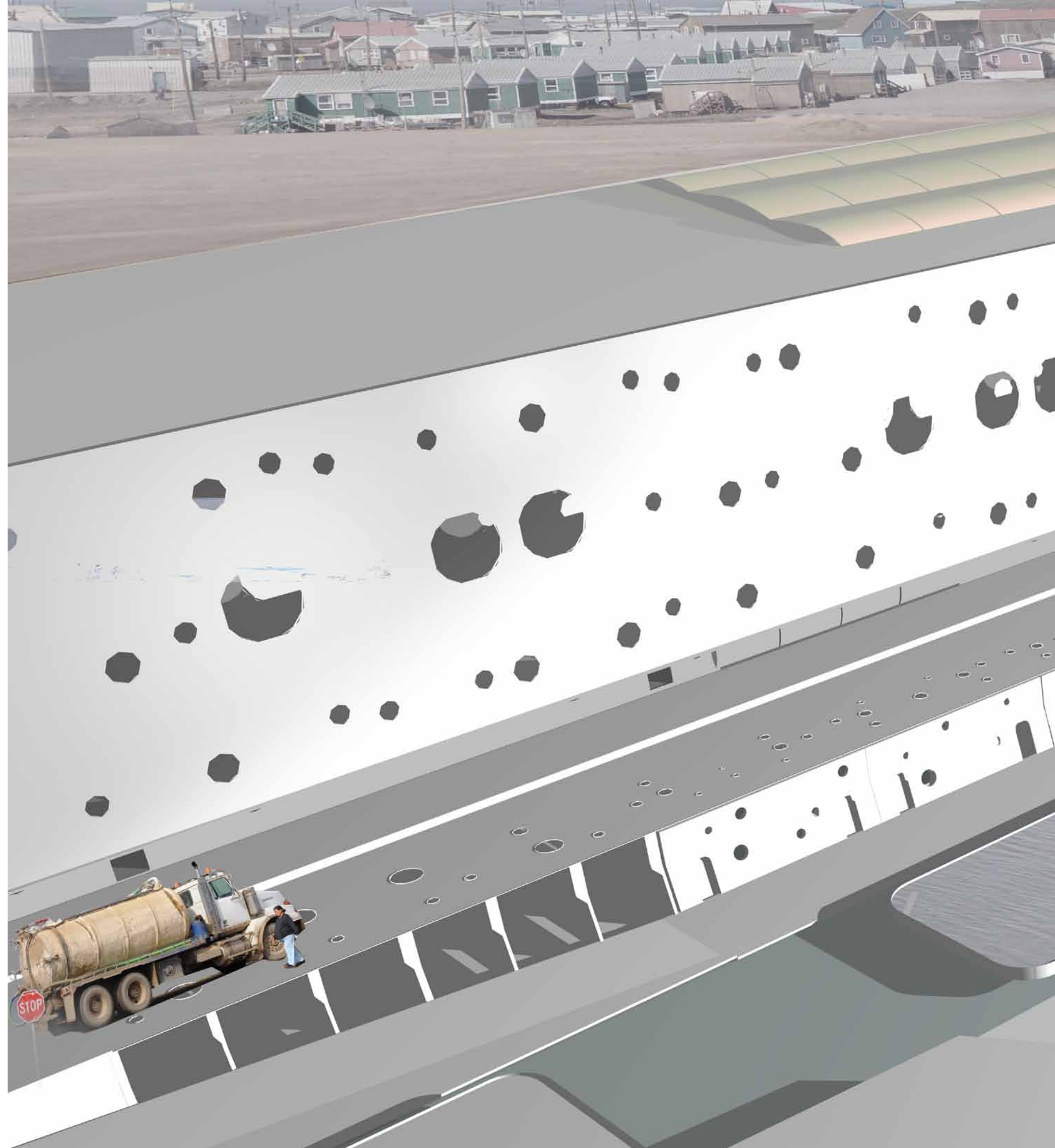




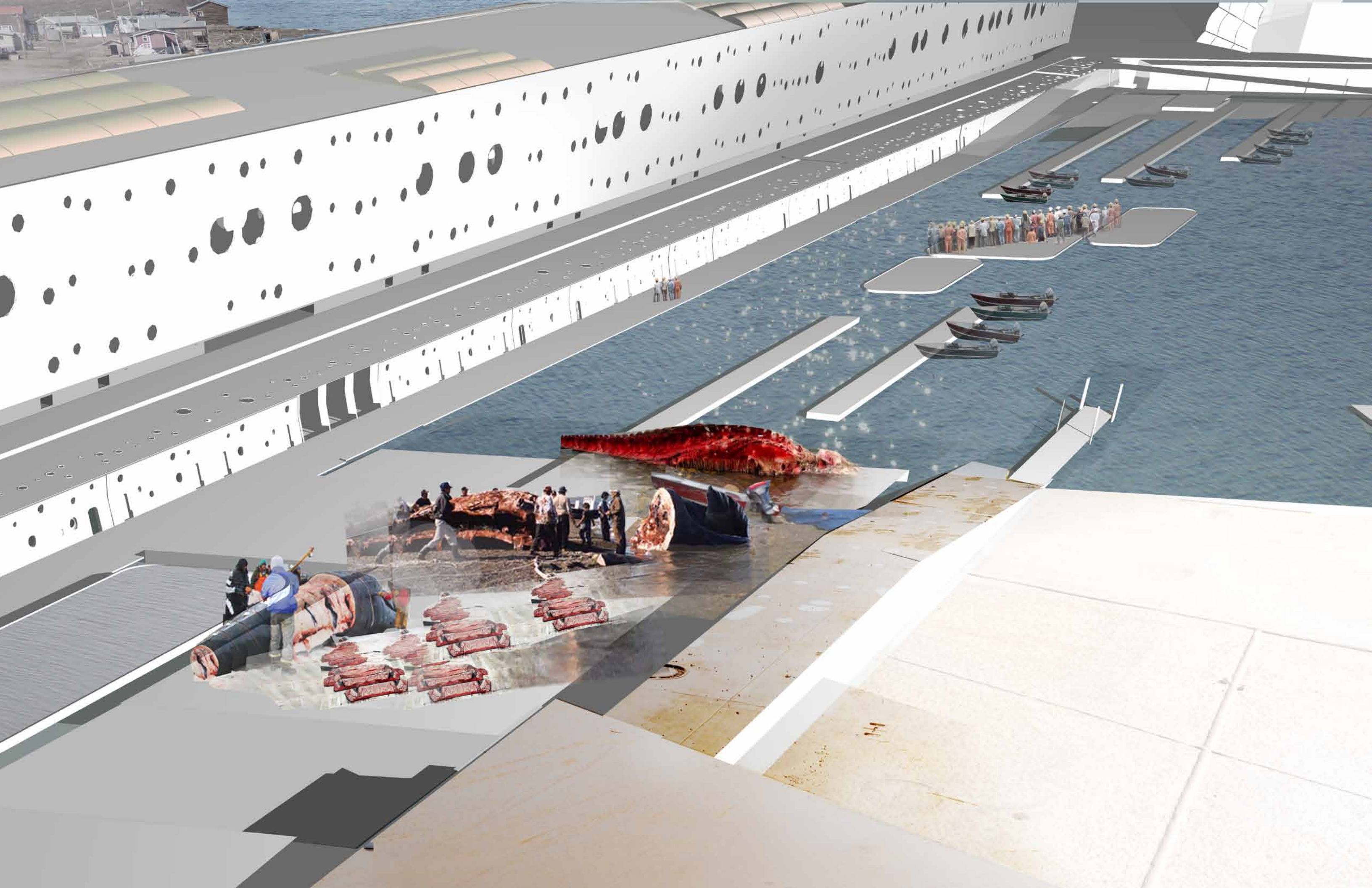


## ARCTIC SCENARIOS : 2015 - 2030

The development and occupation of the Tuktoyaktuk harbour takes advantage of the finite economic opportunity to secure land for future development and to secure housing for the local population. In its construction, it will see to the co-existence of the oil industry - as they maximize their use of the harbour and its housing facilities - and the local community. The local community, in this scenario, will both engage with the economy and business of the oil operations while keeping up with their cultural practices of the living withing the complex ecologies of the land. The structure and slopes of the harbour will provide access for boats, fishing and whaling, while securing new land on which to construct housing and the indoor greenhouse space.









# ARCTIC SCENARIOS : 2050 - 2060

Upon the retreat of the oil industry, the Tuktoyaktuk harbour will already be set up as a vital hub for Northern logistics and transportation. Assuming the rise of sea levels, the inundation of the harbour will provide the port with deepwater access that will facilitate many of the marine functions of the booming economy. As the oil operations gradually slow down and retreat over the past 10 years, the harbour will have seen the transition from an oil economy to a marine economy through the infrastructures already in place. The port once operated by the oil industry will be taken over to allow for the distribution of recycled wastes from the site. Among these wastes are HAZMATS from the drilling operations as well as recyclables from vessel disassembly from the Vessel Graveyard. The Tuktoyaktuk Materials Packing and Distribution Plant will be required to ship these materials via barge, down south to be correctly recycled and given new life.

Another remediative tactic is the use of safe landfilling strategies as well as wastewater treatment ponds. These mechanisms help to repair the damages of the oil operations, while proactively giving back to the local landscape and community.

As well, with increased access from the Northwest Passage that is actively open at this point, the presence of the Canadian Coast Guard will fill the harbour with service and monitoring vessels as well as Search and Rescue equipment. Many of the emergency response facilities can transition from some of the Oil Spill Response facilities and Harbour Management facilities set up by the oil industry.

Finally, at this point, the production of a harvested landscape will occur in the greenhouse spaces of each building. This Arctic resource will couple with a large Arctic Distribution Centre, Market and Food Warehouse (including community freezer). Also supplying this economy, is the active fish-farming taking place throughout the site. The capacities of this nutritive system, serve the community of Tuktoyaktuk at first. However, as the system grows, it can expand into a larger distribution centre and marketplace for Northern communities to have access to more nutritious sustenance.



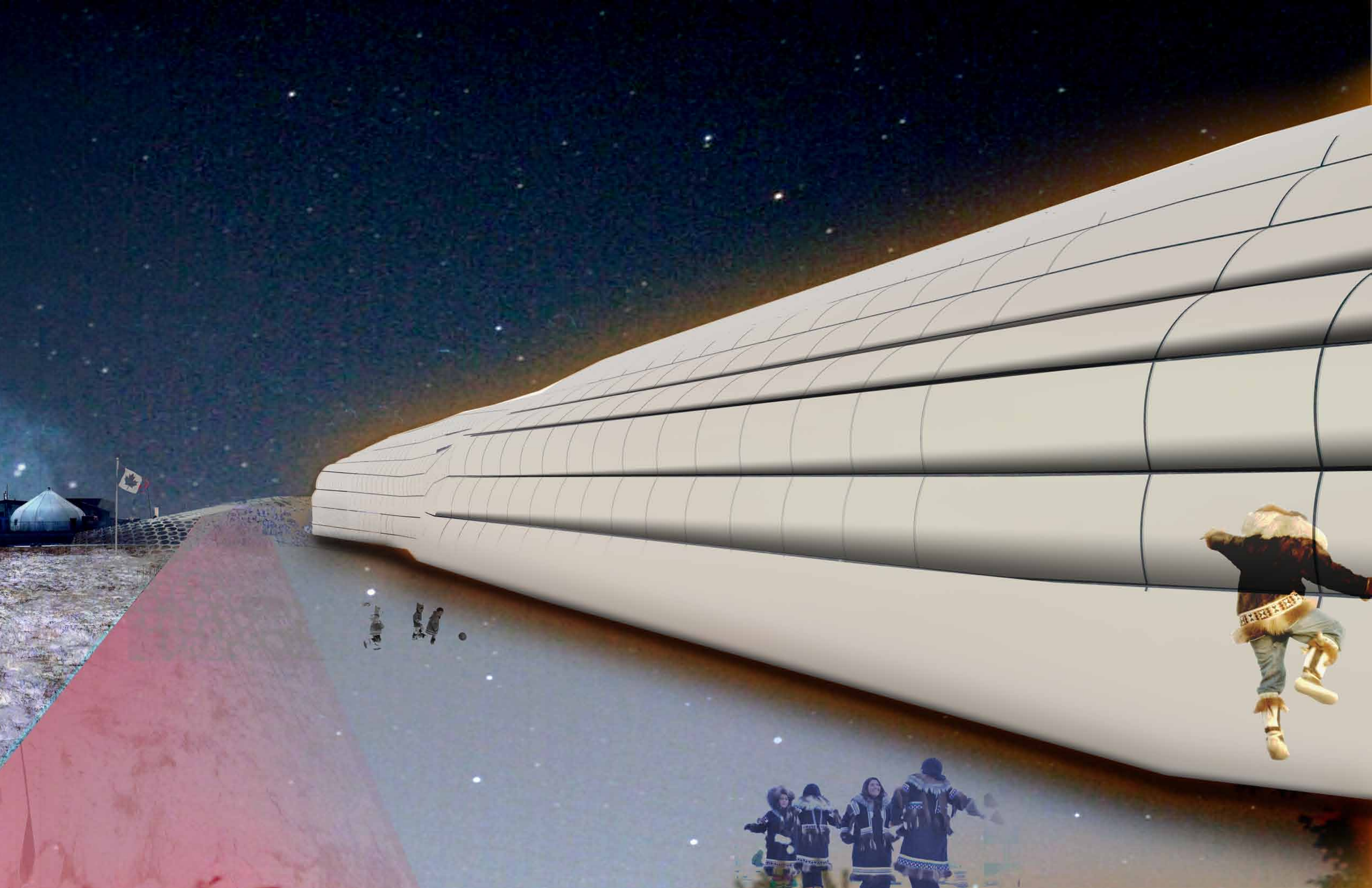










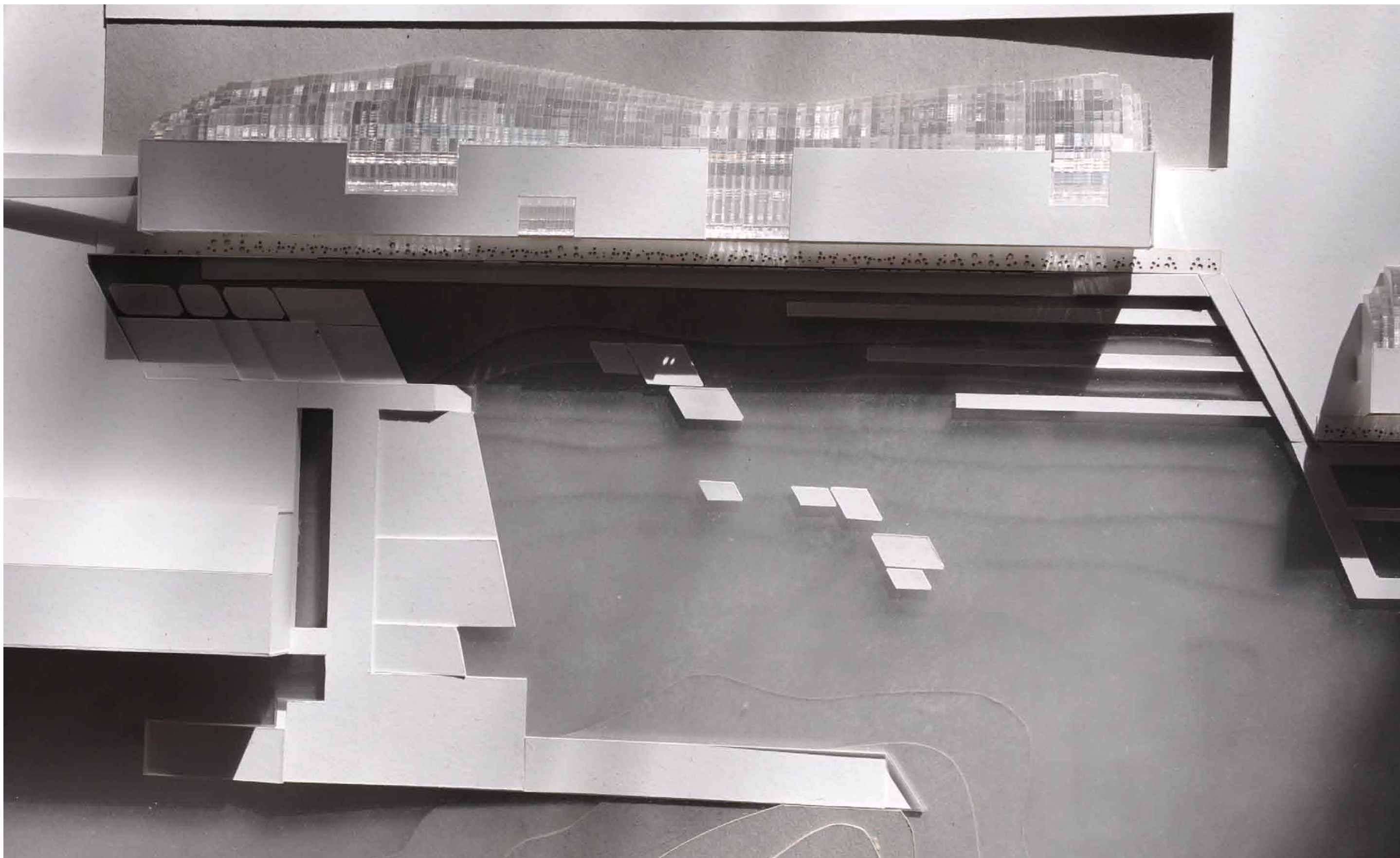


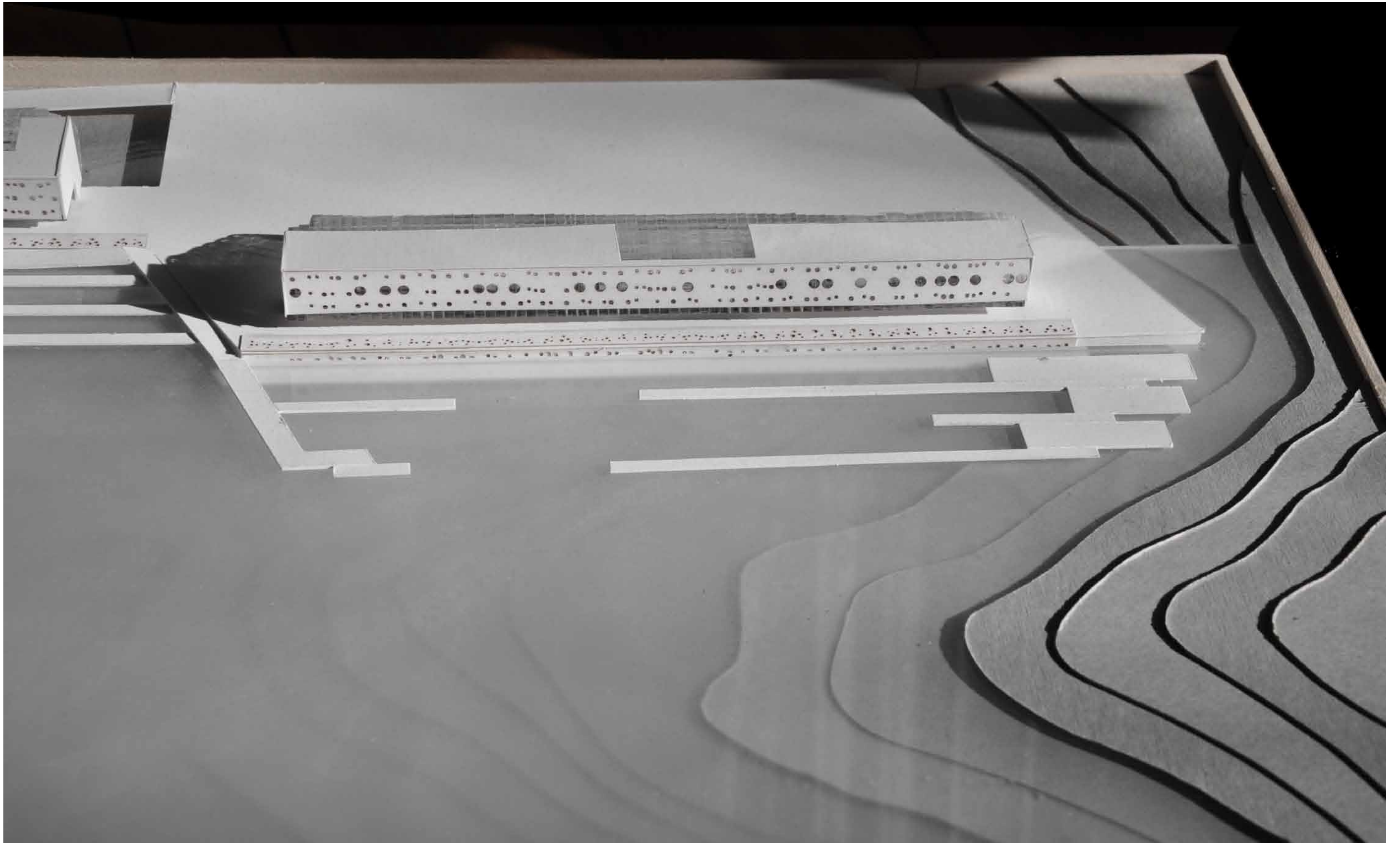


# THE NETWORKED FRONTIER : A **NATIONAL** IMPERATIVE

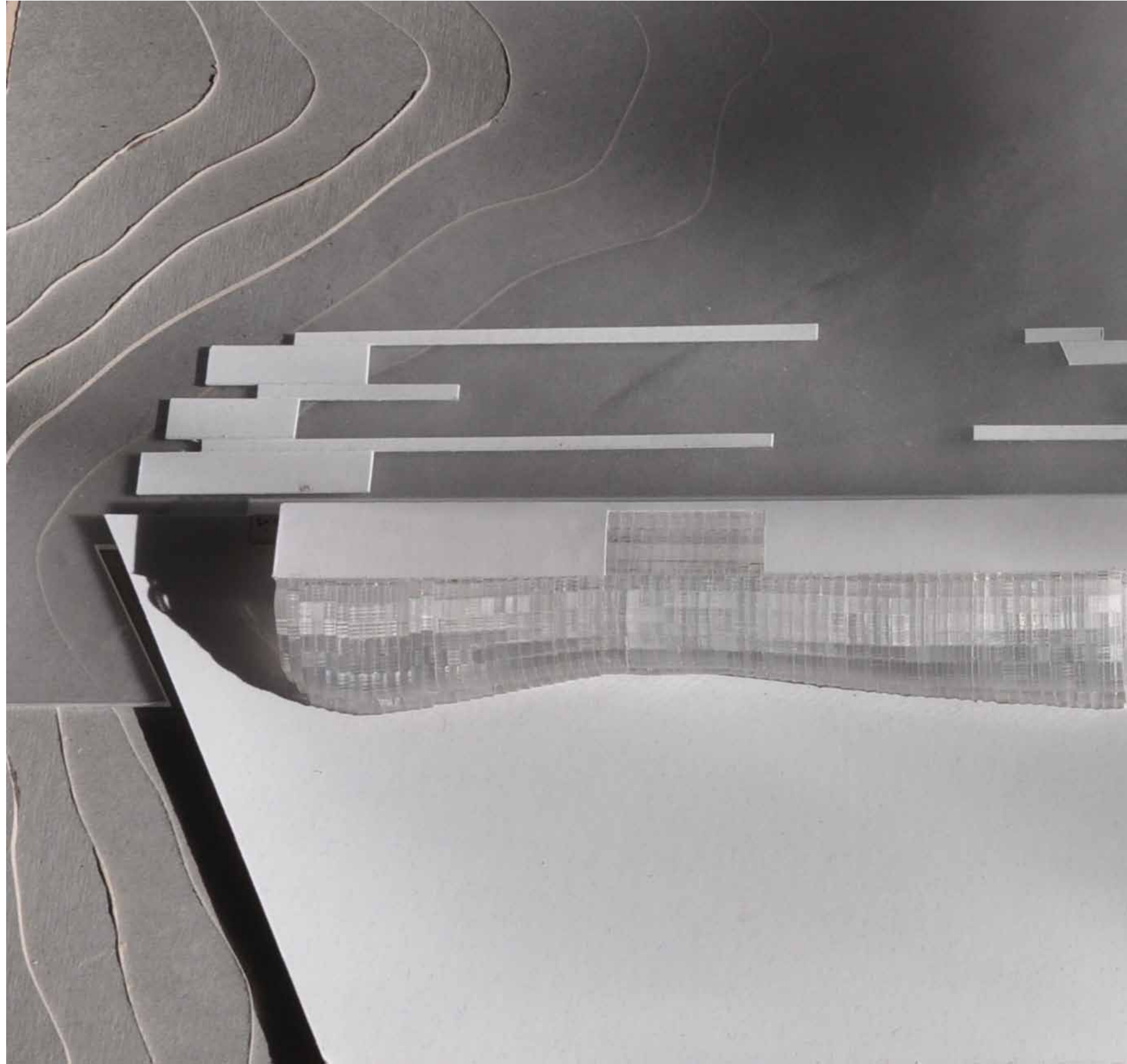


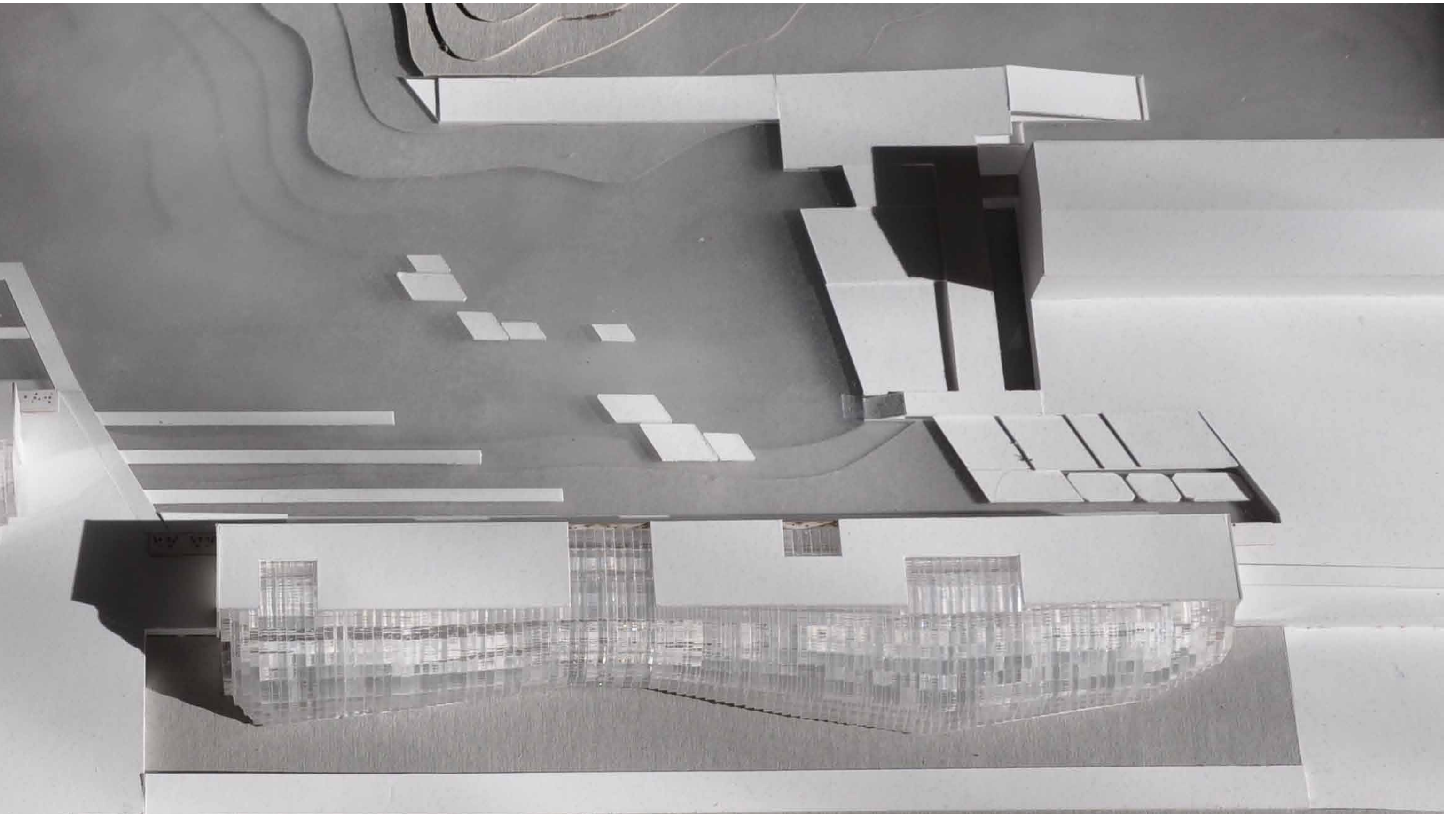














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